APPENDIX H

STATISTICAL AND GEOCHEMICAL EVALUATION OF SITE METALS DATA

STATISTICAL
(TIERS 1 AND 2)

Statistical Comparison of Site and Background Data
Range 31: Weapons Demonstration Range and Defendum Field Firing Range No. 2, Parcels 89Q-X and 215Q
Fort McClellan, Alabama

1.0 Introduction

This report provides the Tier 1 and Tier 2 (Shaw E&I, 2003) site-to-background comparison results for Range 31: Weapons Demonstration Range and Defendum Field Firing Range No. 2, Parcels 89Q-X and 215Q, at Fort McClellan in Calhoun County, Alabama. In the first step of the comparison, the maximum detected concentration (MDC) of each element is compared to two times the arithmetic mean of the background data (SAIC, 1998). Any metal that has an MDC greater than the background screening value is carried forward for Tier 2 evaluation, which includes the Slippage Test and the Wilcoxon Rank Sum Test (WRS). If either or both of these statistical test cannot be done, the evaluation will include the Hot Measurement Test.

The methodology and results of the Tier 1 and Tier 2 comparisons are summarized in Tables 1 through 3, and described in more detail in the following sections. Site samples used in the site-to-background comparison include 47 surface soil samples (0 to 1 foot below ground surface [bgs]), 42 subsurface soil samples (1 to 4 feet bgs), and 4 groundwater samples that were collected at the site.

Background distributions and screening values have been established for target analyte list metals in surface soil, subsurface soil, and groundwater for Fort McClellan (SAIC, 1998).

2.0 Comparison Methodology

This section describes the statistical techniques that were employed in the Range 31 site-to-background comparison.

2.1 Statistical Procedures

Contamination can be caused by a variety of processes that yield different spatial distributions of elevated contaminant concentrations. Slight but pervasive contamination can occur from non-point-source releases, and can result in slight increases in contaminant concentrations in a large percentage of samples. Localized, or "hot-spot," contamination can result in elevated concentrations in a small percentage of the total number of site samples. No single two-sample statistical comparison test is sensitive to both of these modes of contamination. For this reason,

Table 1

Summary of Tier 1 and Tier 2 Site to Background Comparison for Surface Soil
Range 31: Weapons Demonstration Range and Defendum Field Firing Range No. 2, Parcels 89Q-X and 215Q
Fort McClellan, Calhoun County, Alabama

Metals	Frequency of Detection	Tier 1 Evaluation[a]	Tier 2 Evaluation: Slippage Test[b]	Tier 2 Evaluation: Wilcoxon Rank Sum Test[b]	Tier 2 Evaluation: Hot Measurement Test[b,c]	Carried Forward for Tier 3 Geochemical Evaluation
Aluminum	46 / 47	Failed	Passed	Passed	NA	
Antimony	0 / 47	NA	NA	NA	NA	
Arsenic	44 / 47	Passed	NA	NA	NA	
Barium	47 / 47	Failed	Passed	Passed	NA	
Beryllium	13 / 47	Failed	Passed	NA[d]	Passed	
Cadmium	0 / 47	NA	NA	NA	NA	
Calcium	46 / 47	Passed	NA	NA	NA	
Chromium	47 / 47	Passed	NA	NA	NA	
Cobalt	33 / 47	Passed	NA	NA	NA	
Copper	47 / 47	Failed	Failed	Failed	NA	Yes
Iron	47 / 47	Passed	NA	NA	NA	
Lead	47 / 47	Failed	Failed	Failed	NA	Yes
Magnesium	47 / 47	Failed	Passed	Failed	NA	Yes
Manganese	47 / 47	Passed	NA	NA	NA	
Mercury	30 / 47	Failed	Passed	NA[d]	Failed	Yes
Nickel	43 / 47	Passed	NA	NA	NA	
Potassium	40 / 47	Passed	NA	NA	NA	
Selenium	12 / 47	Failed	Passed	Failed	NA	Yes
Silver	0 / 47	NA	NA	NA	NA	
Sodium	21 / 47	Passed	NA	NA	NA	
Thallium	1 / 47	Passed	NA	NA	NA	
Vanadium	47 / 47	Passed	NA	NA	NA	
Zinc	47 / 47	Failed	Passed	Passed	NA	

NA = not applicable

a Tier 1 evaluation per ***Selecting Site-Related Chemicals for Human Health and Ecological Risk Assessments for FTMC, Revision 2***, Technical Memorandum, 24 June 2003 by Paul Goetchius.

b Part of Tier 2 evaluation per the above referenced memo.

c Performed only when the Slippage test and/or Wilcoxon and Rank Sum (WRS) test cannot be performed.

d WRS test is not performed on data sets containing 50% or more nondetects.

Table 2

Summary of Tier 1 and Tier 2 Site to Background Comparison for Subsurface Soil
Range 31: Weapons Demonstration Range and Defendum Field Firing Range No. 2, Parcels 89Q-X and 215Q
Fort McClellan, Calhoun County, Alabama

Metals	Frequency of Detection	Tier 1 Evaluation[a]	Tier 2 Evaluation: Slippage Test[b]	Tier 2 Evaluation: Wilcoxon Rank Sum Test[b]	Tier 2 Evaluation: Hot Measurement Test[b,c]	Carried Forward for Tier 3 Geochemical Evaluation
Aluminum	42 / 42	Failed	Passed	Failed	NA	Yes
Antimony	0 / 42	NA	NA	NA	NA	
Arsenic	41 / 42	Passed	NA	NA	NA	
Barium	42 / 42	Passed	NA	NA	NA	
Beryllium	7 / 42	Passed	NA	NA	NA	
Cadmium	0 / 42	NA	NA	NA	NA	
Calcium	41 / 42	Failed	Passed	Passed	NA	
Chromium	42 / 42	Failed	Passed	Passed	NA	
Cobalt	31 / 42	Passed	NA	NA	NA	
Copper	41 / 42	Failed	Passed	Passed	NA	
Iron	42 / 42	Failed	Passed	Passed	NA	
Lead	42 / 42	Failed	Passed	Passed	NA	
Magnesium	42 / 42	Failed	Passed	Failed	NA	Yes
Manganese	42 / 42	Passed	NA	NA	NA	
Mercury	29 / 42	Failed	Passed	NA[e]	Failed	Yes
Nickel	39 / 42	Passed	NA	NA	NA	
Potassium	40 / 42	Failed	Passed	Failed	NA	Yes
Selenium	12 / 42	Failed	NA[d]	NA[e]	Failed	Yes
Silver	0 / 42	NA	NA	NA	NA	
Sodium	19 / 42	Passed	NA	NA	NA	
Thallium	1 / 42	Failed	Passed	NA[e]	Passed	
Vanadium	42 / 42	Failed	Passed	Passed	NA	
Zinc	42 / 42	Passed	NA	NA	NA	

NA = not applicable; MDC = maximum detected concentration

a Tier 1 evaluation (site MDC compared to 2 x the background mean) per ***Selecting Site-Related Chemicals for Human Health and Ecological Risk Assessments for FTMC, Revision 2***, Technical Memorandum, 24 June 2003 by Paul Goetchius.

b Part of Tier 2 evaluation per the above referenced memo.

c Performed only when the Slippage test and/or WRS test cannot be performed.

d Slippage test is not performed on data sets for which the maximum background value is a nondetect.

e WRS test is not performed on data sets containing 50% or more nondetects.

Table 3

Summary of Tier 1 and Tier 2 Site to Background Comparison for Groundwater
Range 31: Weapons Demonstration Range and Defendum Field Firing Range No. 2, Parcels 89Q-X and 215Q
Fort McClellan, Calhoun County, Alabama

Metals	Frequency of Detection	Tier 1 Evaluation[a]	Tier 2 Evaluation: Slippage Test[b]	Tier 2 Evaluation: Wilcoxon Rank Sum Test[b]	Tier 2 Evaluation: Hot Measurement Test[b,c]	Carried Forward for Tier 3 Geochemical Evaluation
Aluminum	4 / 4	Passed	NA	NA	NA	
Antimony	0 / 4	NA	NA	NA	NA	
Arsenic	0 / 4	NA	NA	NA	NA	
Barium	4 / 4	Passed	NA	NA	NA	
Beryllium	0 / 4	NA	NA	NA	NA	
Cadmium	0 / 4	NA	NA	NA	NA	
Calcium	4 / 4	Passed	NA	NA	NA	
Chromium	0 / 4	NA	NA	NA	NA	
Cobalt	0 / 4	NA	NA	NA	NA	
Copper	1 / 4	Passed	NA	NA	NA	
Iron	4 / 4	Passed	NA	NA	NA	
Lead	1 / 4	Passed	NA	NA	NA	
Magnesium	4 / 4	Passed	NA	NA	NA	
Manganese	4 / 4	Passed	NA	NA	NA	
Mercury	0 / 4	NA	NA	NA	NA	
Nickel	0 / 4	NA	NA	NA	NA	
Potassium	2 / 4	Failed	Passed	NA[e]	Passed	
Selenium	1 / 4	Failed	NA[d]	NA[e]	Passed	
Silver	0 / 4	NA	NA	NA	NA	
Sodium	3 / 4	Passed	NA	NA	NA	
Thallium	0 / 4	NA	NA	NA	NA	
Vanadium	0 / 4	NA	NA	NA	NA	
Zinc	0 / 4	NA	NA	NA	NA	

NA = not applicable; MDC = maximum detected concentration

a Tier 1 evaluation (site MDC compared to 2 x the background mean) per ***Selecting Site-Related Chemicals for Human Health and Ecological Risk Assessments for FTMC, Revision 2***, Technical Memorandum, 24 June 2003 by Paul Goetchius.

b Part of Tier 2 evaluation per the above referenced memo.

c Performed only when the Slippage test and/or WRS test cannot be performed.

d Slippage test is not performed on data sets for which the maximum background value is a nondetect.

e WRS test is not performed on data sets with a sample size less than 5.

the use of several simultaneous tests is recommended for a valid and complete comparison of site versus background distributions (U.S. Environmental Protection Agency [EPA], 1989, 1992, and 1994; U.S. Navy, 2002).

Analytes that fail the Tier 1 and Tier 2 comparisons are subject to a geochemical evaluation to determine if the elevated concentrations are due to natural processes or if they represent potential contamination.

2.1.1 Tier 1

In this step of the background screening process, the MDC of the site data set is compared to the background screening value of two times the background mean (SAIC, 1998). Elements for which the site MDC does not exceed the background screening value are considered to be present at background concentrations, and are not considered site-related chemicals. Elements for which the site MDC exceeds the background screening value undergo further evaluation (Tier 2).

2.1.2 Tier 2

Slippage Test. The nonparametric Slippage test is designed to detect a difference between the upper tails of two distributions, and has been recommended for use in site-to-background comparisons to identify potential localized, or hot-spot, contamination (U.S. Navy, 2002). The test is performed by counting the number (K) of detected concentrations in the site data set that exceed the maximum background measurement, and then comparing this number to a critical value (K_c), which is a function of the number of background samples and the number of site samples. If $K > K_c$, then potential contamination is indicated and the analyte will be subjected to geochemical evaluation. If $K \leq K_c$, then localized contamination is not suspected.

Critical values tables for site and background data sets up to size $n = 50$ are provided in U.S. Navy (2002). Critical values for larger data sets are calculated using the test statistic provided in Rosenbaum (1954). In this report, the Slippage test is performed at the 95 percent confidence level. The test cannot be performed if the maximum background value is a nondetect, because the actual concentration in that sample is unknown.

Wilcoxon Rank Sum Test. The nonparametric WRS test is designed to detect a difference between the medians of two data sets, and has been recommended for use in site-to-background comparisons to identify slight but pervasive contamination (EPA, 2000; U.S. Navy, 2002). In this report, the WRS test is performed when the site and background data sets each contain less than 50 percent nondetects (i.e., measurements reported as not detected below the laboratory reporting limit). The WRS test will not be performed on data sets containing 50 percent or more nondetects. The medians of such data sets are unknown, and hence the test results would lack sufficient power to yield reliable results.

The WRS test compares two data sets of size n and m ($n > m$), and tests the null hypothesis that the samples were drawn from populations with distributions having the same medians. To perform the test, the two sets of observations are pooled and arranged in order from smallest to largest. Each observation is assigned a rank; that is, the smallest is ranked 1, the next largest is ranked 2, and so on up to the largest observation, which is ranked ($n + m$). If ties occur between or within samples, each one is assigned the mid-rank. Next, the sum of the ranks of smaller data set m is calculated. Then the test statistic Z is determined,

$$Z = \frac{W - m(m+n+1)/2}{\sqrt{mn(m+n+1)/12}}$$

Where:

W = Sum of the ranks of the smaller data set
m = Number of data points in smaller group
n = Number of data points in larger group.

This test statistic Z is used to find the two-sided significance. For instance, if the test statistic yields a probability of a Type I error (p-level) less than 0.2, then there is a statistically significant difference between the medians at the 80 percent confidence level. A Type I error involves rejecting the null hypothesis when it is true. If the p-level is greater than 0.2, then there is no reasonable justification to reject the null hypothesis at the 80 percent confidence level. It can therefore be concluded that the medians of the two data sets are similar, and it can be assumed to be drawn from the same population.

If the p-level is less than 0.2, then the medians of the two distributions are significantly different at the 80 percent confidence level. This can occur if the site data are shifted higher or lower than the background data. If the site data are shifted higher relative to background, then contamination may be indicated, and the analyte in question will be carried on for geochemical evaluation; however, if the site data are shifted lower relative to background, then contamination is not indicated. If the p-level is greater than 0.2, then pervasive site contamination is not suspected.

Box Plots. A quick, robust graphical method recommended by the EPA to visualize and compare two or more groups of data is the box plot comparison (EPA, 1989 and 1992). These plots provide a summary view of the entire data set, including the overall location and degree of symmetry. The box encloses the central 50 percent of the data points so that the top of the box represents the 75th percentile and the bottom of the box represents the 25th percentile. The small box within the larger box represents the median of the data set. The upper whisker extends outward from the box to the maximum point and the lower whisker extends to the minimum point. Nondetect results are set equal to one-half of the reporting limit for plotting purposes.

For each analyte, box plots of site and background data are placed side by side to visually compare the distributions and qualitatively determine whether the data sets are similar or distinct. Accordingly, the box plots are a necessary adjunct to the WRS test. As described previously, the WRS test may indicate that the medians of the site and background data sets are significantly different. Examination of the box plots will confirm whether that difference is caused by site data that are shifted higher or lower relative to background.

Hot Measurement Test. The hot measurement test consists of comparing each site measurement with a concentration value that is representative of the upper limit of the background distribution (EPA, 1994). Ideally, a site sample with a concentration above the background screening value would have a low probability of being a member of the background distribution, and may be an indicator of contamination. It is important to select such a background screening value carefully so that the probability of falsely identifying site samples as contaminated or uncontaminated is minimized.

The 95th upper tolerance limit (95th UTL) is recommended as a screening value for normally or lognormally distributed analytes and the 95th percentile is recommended as a screening value for nonparametrically distributed analytes (EPA, 1989, 1992, and 1994). Site samples with concentrations above these values are not necessarily contaminated, but should be considered suspect. To perform the test, each analyte's site MDC is compared to the background 95th UTL or 95th percentile, in accordance with the type of background distribution. If the site MDC exceeds the background screening value, then that analyte will undergo a geochemical evaluation. If the MDC does not exceed the background threshold value, then hot-spot contamination is not indicated.

2.1.3 Geochemical Evaluation

If an analyte fails either of the statistical tests described above, then a geochemical evaluation is performed to determine if the elevated concentrations are caused by natural processes. The methodology and results of the geochemical evaluation are provided separately.

3.0 Results of the Site-to-Background Comparisons

This section presents the results of the site-to-background comparisons for 23 TAL metals in the Range 31 surface soil, subsurface soil, and groundwater samples. Tables 1 through 3 summarize the Tier 1 and Tier 2 test results for each media as discussed in the following sections. Statistical test results are discussed in detail below. Box plots are also discussed below and are provided in Attachment 1.

3.1 Surface Soil

Twenty-three TAL metals were evaluated in the Range 31 surface soil. Three metals (antimony, cadmium, and silver) had no detected concentrations in surface soil. No further discussion of these metals is included.

Eleven metals (arsenic, calcium, chromium, cobalt, iron, manganese, nickel, potassium, sodium, thallium, and vanadium) had no detected concentrations above their respective background screening values, passing the Tier 1 evaluation. These metals are considered to be within the range of background and will not be tested or discussed any further.

The remaining 9 metals underwent Tier 2 evaluation. The statistical test results and box plots are discussed in detail below.

Table 1 summarizes the Tier 1 and Tier 2 test results for surface soil.

Aluminum

Tier 1 Evaluation

Three site samples exceed the background screening value of 16,306 milligrams per kilogram (mg/kg).

Tier 2 Evaluation

Slippage Test

The critical value, K_c, for aluminum is 4. No site samples exceed the maximum background measurement (K=0). Because $K < K_c$, aluminum passes the Slippage test.

WRS Test
The WRS test p-level of 0.515 indicates a strong agreement between the site and background distributions.

Box Plot
Box plots comparing the site and background data sets are provided in Figure 1-1. The site minimum is significantly lower than that of background. The site interquartile range is similar to the corresponding background range, and the site maximum is less than that of background.

Conclusion
Aluminum in surface soil passed the Tier 2 evaluation and is considered to be within the range of background.

Barium

Tier 1 Evaluation
Two site samples exceed the background screening value of 123.94 mg/kg.

Tier 2 Evaluation
Slippage Test
K_c for barium is 4, and no site samples exceed the maximum background measurement. Because $K < K_c$, barium passes the Slippage test.

WRS Test
The WRS test p-level of 0.396 indicates a good agreement between the site and background distributions.

Box Plot
The site minimum, 25th percentile, and median are slightly elevated as compared to the corresponding background values (Figure 1-1). The site 75th percentile is similar to that of background, and the site maximum is less than the corresponding background value.

Conclusion
Because barium in surface soil failed statistical comparison to background, it will be carried forward for Tier 3 geochemical evaluation.

Beryllium

Tier 1 Evaluation
Four site samples exceed the background screening value of 0.8 mg/kg.

Tier 2 Evaluation
Slippage Test
K_c for beryllium is 5, and one site sample exceeds the maximum background measurement. Because $K < K_c$, beryllium passes the Slippage test.

WRS Test
The WRS test was not performed because the site data set contains more than 50 percent nondetects.

Box Plot
The site minimum, 25th percentile, and median are higher than the corresponding background values (Figure 1-2). The site 75th percentile and maximum are similar to that of background. The shape and location of the site box plot are influenced by the percentage of nondetects (72 percent), and the replacement values of one-half the reporting limit, rather than detected concentrations.

Hot Measurement Test
The site MDC for beryllium is less than the background 95th UTL of 1.189 mg/kg.

Conclusion
Because beryllium in surface soil passed the Tier 2 evaluation, it is considered to be within the range of background.

Copper

Tier 1 Evaluation
Sixteen site samples exceed the background screening value of 12.71 mg/kg.

Tier 2 Evaluation
Slippage Test
K_c for copper is 4, and 10 site samples exceed the maximum background measurement. Because $K > K_c$, copper fails the Slippage test.

WRS Test
The WRS test p-level of 0.0436 indicates a significant difference between the site and background distributions.

Box Plot
The site 25th percentile and median are similar to the corresponding background values (Figure 1-2). The site minimum, 75th percentile, and maximum are higher compared to the respective background values.

Conclusion
Because copper in surface soil failed statistical comparison to background, it will be carried forward for Tier 3 geochemical evaluation.

Lead

Tier 1 Evaluation
Twelve site samples exceed the background screening value of 40.05 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for lead is 4, and 9 site samples exceed the maximum background measurement. Because $K > K_c$, lead fails the Slippage test.

WRS Test

The WRS test p-level of 0.037 indicates a significant difference between the site and background distributions.

Box Plot

The site minimum is less than that of background. The site 25th percentile is slightly higher than the corresponding background values (Figure 1-3). The site median, 75th percentile, and maximum are significantly higher than the corresponding background values.

Conclusion

Because lead in surface soil failed statistical comparison to background, it will be carried forward for Tier 3 geochemical evaluation.

Magnesium

Tier 1 Evaluation

One site sample exceeds the background screening value of 1,033 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for magnesium is 4, and no site samples exceed the maximum background measurement. Because $K < K_c$, magnesium passes the Slippage test.

WRS Test

The p-level of 0.0077 indicates a significant difference between the site and background distributions.

Box Plot

The site minimum, 25th percentile, and median are higher than the corresponding background values (Figure 1-3). The site and background 75th percentiles are similar, and the site maximum is lower compared to that of background.

Conclusion

Because magnesium in surface soil failed statistical comparison to background, it will be carried forward for Tier 3 geochemical evaluation.

Mercury

Tier 1 Evaluation

Three site samples exceed the background screening value of 0.08 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for mercury is 4, and no site samples exceed the maximum background measurement. Because $K < K_c$, mercury passes the Slippage test.

WRS Test

No WRS test was performed because the background data set contains more than 50 percent nondetects.

Box Plot

The site minimum and interquartile range are higher than the corresponding background values (Figure 1-4). The site maximum is lower than that of background. The shape and location of the background box plot are influenced by the high percentage of nondetects (66 percent), and the replacement values of one-half the reporting limit, rather than detected concentrations.

Hot Measurement Test

The site MDC of mercury is greater than the background 95^{th} percentile of 0.125 mg/kg.

Conclusion

Because mercury in surface soil failed statistical comparison to background, it will be carried forward for Tier 3 geochemical evaluation.

Selenium

Tier 1 Evaluation

Twelve site samples exceed the background screening value of 0.48 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for selenium is 4, and 2 site samples exceed the maximum background measurement. Because $K < K_c$, selenium passes the Slippage test.

WRS Test

No WRS test was performed because the site and background data sets contain more than 50 percent nondetects.

Box Plot

The site minimum, interquartile range, and maximum are higher than the corresponding background values (Figure 1-4). The shapes and locations of the background and site box plots are influenced by the high percentage of nondetects (99 percent and 74 percent, respectively), and the replacement values of one-half the reporting limit, rather than detected concentrations.

Hot Measurement Test

The site MDC exceeds the background 95^{th} percentile of 0.563 mg/kg.

Conclusion
Because selenium in surface soil failed statistical comparison to background, it will be carried forward for Tier 3 geochemical evaluation.

Zinc

Tier 1 Evaluation
One site sample exceeds the background screening value of 40.64 mg/kg.

Tier 2 Evaluation
Slippage Test
K_c for zinc is 4, and no site samples exceed the maximum background measurement. Because $K < K_c$, zinc passes the Slippage test.

WRS Test
The p-level of 0.497 indicates a good agreement between the site and background distributions.

Box Plot
The site minimum and 25th percentile are higher than the corresponding background values (Figure 1-5). The site median, 75th percentile, and maximum are lower as compared to background.

Conclusion
Zinc in surface soil is considered to be within the range of background.

3.2 Subsurface Soil

Twenty-three TAL metals were evaluated in Range 31, subsurface soil. Three metals (antimony, cadmium, and silver) had no detected concentrations in the subsurface soil samples. No further discussion of this metal is included.

Eight metals (arsenic, barium, beryllium, cobalt, manganese, nickel, sodium, and zinc) had no detected concentrations above the background screening values, passing the Tier 1 evaluation. These metals are considered to be within the range of background and no further testing or discussion of these elements is included.

The remaining 12 metals underwent Tier 2 evaluation. The statistical tests and box plots are discussed in detail below.

Table 2 summarizes the Tier 1 and Tier 2 test results for subsurface soil.

Aluminum

Tier 1 Evaluation
Fifteen site samples exceed the background screening value of 13,591 mg/kg.

Tier 2 Evaluation

Slippage Test

The critical value, K_c, for aluminum is 4. Three site samples exceed the maximum background measurement. Because $K < K_c$, aluminum passes the Slippage test.

WRS Test

The p-level < 0.001 indicates a significant difference between the site and background distributions.

Box Plot

The site minimum, interquartile range, and maximum are higher than the corresponding background values (Figure 1-5).

Conclusion

Because aluminum in subsurface soil failed statistical comparison to background, it will be carried forward for Tier 3 geochemical evaluation.

Calcium

Tier 1 Evaluation

One site sample exceeds the background screening value of 637.17 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for calcium is 4, and no site samples exceed the maximum background measurement. Because $K < K_c$, calcium passes the Slippage test.

WRS Test

The p-level of 0.628 indicates a strong agreement between the site and background distributions.

Box Plot

The site minimum, 75th percentile, and maximum are lower than the corresponding background values (Figure 1-6). The site and background medians are similar, and the site 25th percentile is higher than that of background.

Conclusion

Calcium in subsurface soil passed the Tier 2 evaluation and is considered to be within the range of background.

Chromium

Tier 1 Evaluation

One site sample exceeds the background screening value of 38.25 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for chromium is 4, and one site sample exceeds the maximum background measurement. Because $K < K_c$, chromium passes the Slippage test.

WRS Test

The p-level of 0.002 indicates a significant difference between the site and background distributions. Examination of the box plots will confirm the difference is caused by site data that are lower relative to background.

Box Plot

The site minimum and interquartile range are lower than the corresponding background values (Figure 1-6). The site maximum is slightly higher than that of background.

Conclusion

Chromium in subsurface soil passed the Tier 2 evaluation and is considered to be within the range of background.

Copper

Tier 1 Evaluation

One site sample exceeds the background screening value of 19.43 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for copper is 4, and no site samples exceed the maximum background measurement. Because $K < K_c$, copper passes the Slippage test.

WRS Test

The p-level of 0.064 indicates a weak agreement between the site and background distributions. Examination of the box plots will confirm the difference is caused by site data that are lower relative to background.

Box Plot

The site minimum, interquartile range, and maximum are slightly lower than the corresponding background values (Figure 1-7).

Conclusion

Copper in subsurface soil passed the Tier 2 evaluation and is considered to be within the range of background.

Iron

Tier 1 Evaluation

One site sample exceeds the background screening value of 44,817 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for iron is 4, and one site sample exceeds the maximum background measurement. Because $K < K_c$, iron passes the Slippage test.

WRS Test

The p-level < 0.001 indicates a significant difference between the site and background distributions. Examination of the box plots will confirm the difference is caused by site data that are lower relative to background.

Box Plot

The site minimum and interquartile range are lower than the corresponding background values (Figure 1-7). The site maximum is greater than that of background.

Conclusion

Iron in subsurface soil is considered to be within the range of background.

Lead

Tier 1 Evaluation

Four site samples exceed the background screening value of 38.53 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for lead is 4, and no site samples exceed the maximum background measurement. Because $K < K_c$, lead passes the Slippage test.

WRS Test

The p-level of 0.51 indicates a strong agreement between the site and background distributions.

Box Plot

The site 25th percentile and median are slightly lower than the corresponding background values (Figure 1-8). The site and background 75th percentiles are similar, and the site maximum is lower than that of background. The site minimum is higher compared to that of background.

Conclusion

Lead in subsurface soil is considered to be within the range of background.

Magnesium

Tier 1 Evaluation

Four site samples exceed the background screening value of 766.24 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for magnesium is 4, and no site samples exceed the maximum background measurement. Because $K < K_c$, magnesium passes the Slippage test.

WRS Test
The p-level < 0.001 indicates a significant difference between the site and background distributions.

Box Plot
The site minimum and interquartile range are higher than the corresponding background values (Figure 1-8). The site maximum is less than that of background.

Conclusion
Because magnesium in subsurface soil failed statistical comparison to background, it will be carried forward for Tier 3 geochemical evaluation.

Mercury

Tier 1 Evaluation
Seven site samples exceed the background screening value of 0.07 mg/kg.

Tier 2 Evaluation
Slippage Test
K_c for mercury is 4, and 2 site samples exceed the maximum background measurement. Because $K < K_c$, mercury passes the Slippage test.

WRS Test
The WRS test is not performed because the background data set contains more than 50 percent nondetects.

Box Plot
The site minimum, interquartile range, and maximum are higher than the corresponding background values (Figure 1-9). The shape and location of the background box plot are influenced by the percentage of nondetects (53 percent), and the replacement values of one-half the reporting limit, rather than detected concentrations.

Hot Measurement Test
The site MDC of mercury exceeds the background 95^{th} percentile of 0.094 mg/kg.

Conclusion
Because mercury in subsurface soil failed statistical comparison to background, it will be carried forward for Tier 3 geochemical evaluation.

Potassium

Tier 1 Evaluation
Two site samples exceed the background screening value of 710.74 mg/kg.

Tier 2 Evaluation
Slippage Test
K_c for potassium is 4, and no site samples exceed the maximum background measurement. Because $K < K_c$, potassium passes the Slippage test.

WRS Test
The p-level of 0.012 indicates a significant difference between the site and background distributions.

Box Plot
The site minimum and interquartile range are higher than the corresponding background values (Figure 1-9). The site maximum is less than that of background.

Conclusion
Because potassium in subsurface soil failed statistical comparison to background, it will be carried forward for Tier 3 geochemical evaluation.

Selenium
Tier 1 Evaluation
Twelve site samples exceed the background screening value of 0.47 mg/kg.

Tier 2 Evaluation
Slippage Test
The Slippage test is not included in the evaluation, because the maximum background result is a nondetect.

WRS Test
The WRS test is not performed because both the site and background data sets have more than 50 percent nondetects.

Box Plot
The site minimum, interquartile range, and maximum are higher than the corresponding background values (Figure 1-10). The shapes and locations of the background and site box plots are influenced by the high percentage of nondetects (99 percent and 71 percent, respectively), and the replacement values of one-half the reporting limit, rather than detected concentrations.

Hot Measurement Test
The site MDC exceeds the background 95th percentile of 0.574 mg/kg.

Conclusion
Because selenium in subsurface soil failed statistical comparison to background, it will be carried forward for Tier 3 geochemical evaluation.

Thallium
Tier 1 Evaluation
One site sample exceeds the background screening value of 1.4 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for thallium is 4, and no site samples exceed the maximum background measurement. Because $K < K_c$, thallium passes the Slippage test.

WRS Test

The WRS test is not performed because the site data set has more than 50 percent nondetects.

Box Plot

The site minimum and interquartile range are higher than the corresponding background values (Figure 1-10). The site maximum is less than that of background. The shape and location of the site box plot are influenced by the high percentage of nondetects (98 percent), and the replacement values of one-half the reporting limit, rather than detected concentrations.

Hot Measurement Test

The site MDC is less than the background 95th percentile of 6.62 mg/kg.

Conclusion

Thallium in subsurface soil passed the Tier 2 evaluation and is considered to be within the range of background.

Vanadium

Tier 1 Evaluation

One site sample exceeds the background screening value of 64.89 mg/kg.

Tier 2 Evaluation

Slippage Test

K_c for vanadium is 4, and no site samples exceed the maximum background measurement. Because $K < K_c$, vanadium passes the Slippage test.

WRS Test

The p-level < 0.001 indicates a significant difference between the site and background distributions. Examination of the box plots will confirm the difference is caused by site data that are lower relative to background.

Box Plot

The site minimum, interquartile range, and maximum are lower than the corresponding background values (Figure 1-11).

Conclusion

Vanadium in subsurface soil passed the Tier 2 evaluation and is considered to be within the range of background.

3.3 Groundwater

This section presents the results of the site-to-background comparisons for 23 TAL metals in unfiltered groundwater samples.

Twelve metals (antimony, arsenic, beryllium, cadmium, chromium, cobalt, mercury, nickel, silver, thallium, vanadium, and zinc) had no detected results in the site samples and are not discussed any further.

Nine metals had no detected concentrations that exceeded their respective background screening values, passing the Tier 1 evaluation. These metals (aluminum, barium, calcium, copper, iron, lead, magnesium, manganese, and sodium) are considered to be within the range of background, and will not be included in any further evaluation or discussion.

The remaining two metals (potassium and selenium) underwent Tier 2 evaluation. The results of the statistical tests are discussed in detail below and summarized in Table 3.

Potassium

Tier 1 Evaluation
Two site samples exceed the background screening value of 7.195 mg/L.

Tier 2 Evaluation
Slippage Test
K_c for potassium is 2, and no site samples exceed the maximum background measurement. Because $K < K_c$, potassium passes the Slippage test.

WRS Test
The WRS test is not performed because the site data set has less than 5 samples.

Box Plot
The site minimum and interquartile range are higher than the corresponding background values (Figure 1-11). The site maximum is lower than that of background.

Hot Measurement Test
The site MDC is less than the background 95th percentile of 16 mg/L.

Conclusion
Because potassium in groundwater passed the Tier 2 evaluation, it is considered to be within the range of background.

Selenium

Tier 1 Evaluation
No background screening value is available for selenium, and one site sample had a detected result.

Tier 2 Evaluation

Slippage Test

Because the maximum background result of selenium is a nondetect, the Slippage test cannot be performed.

WRS Test

The WRS test is not performed because the site data set has less than 5 samples.

Box Plot

The site minimum and interquartile range are higher than the corresponding background values (Figure 1-12). The site maximum is less than that of background. In addition to the small sample size for the site data, the shapes and locations of the background and site box plots are influenced by the high percentage of nondetects (100 percent and 75 percent, respectively), and the replacement values of one-half the reporting limit, rather than detected concentrations.

Hot Measurement Test

The site MDC is less than the background 95th percentile of 0.0971 mg/L.

Conclusion

Selenium in groundwater passed the Tier 2 evaluation and is considered to be within the range of background.

4.0 Summary and Conclusions

The statistical methodology used to compare site data from Range 31 (Parcels 89Q and 215Q) and the background data for 23 TAL elements in surface soil, subsurface soil, and groundwater includes a comparison of the site MDC to the background screening value (Tier 1 evaluation). Analytes that failed this comparison were subjected to the Slippage test and Wilcoxon rank sum test. Box-and-whisker plots were prepared to visually compare the two data sets and properly interpret the WRS test results. If the Slippage test and/or the WRS test could not be performed, the Hot Measurement test was included as part of the Tier 2 statistical evaluation. Analytes that underwent Tier 2 evaluation and failed any component of the statistical site-to-background comparison are carried forward for Tier 3 geochemical evaluation to determine if natural processes can explain the elevated concentrations.

Tables 1 through 3 summarize the comparison test results and the metals carried forward for geochemical evaluation.

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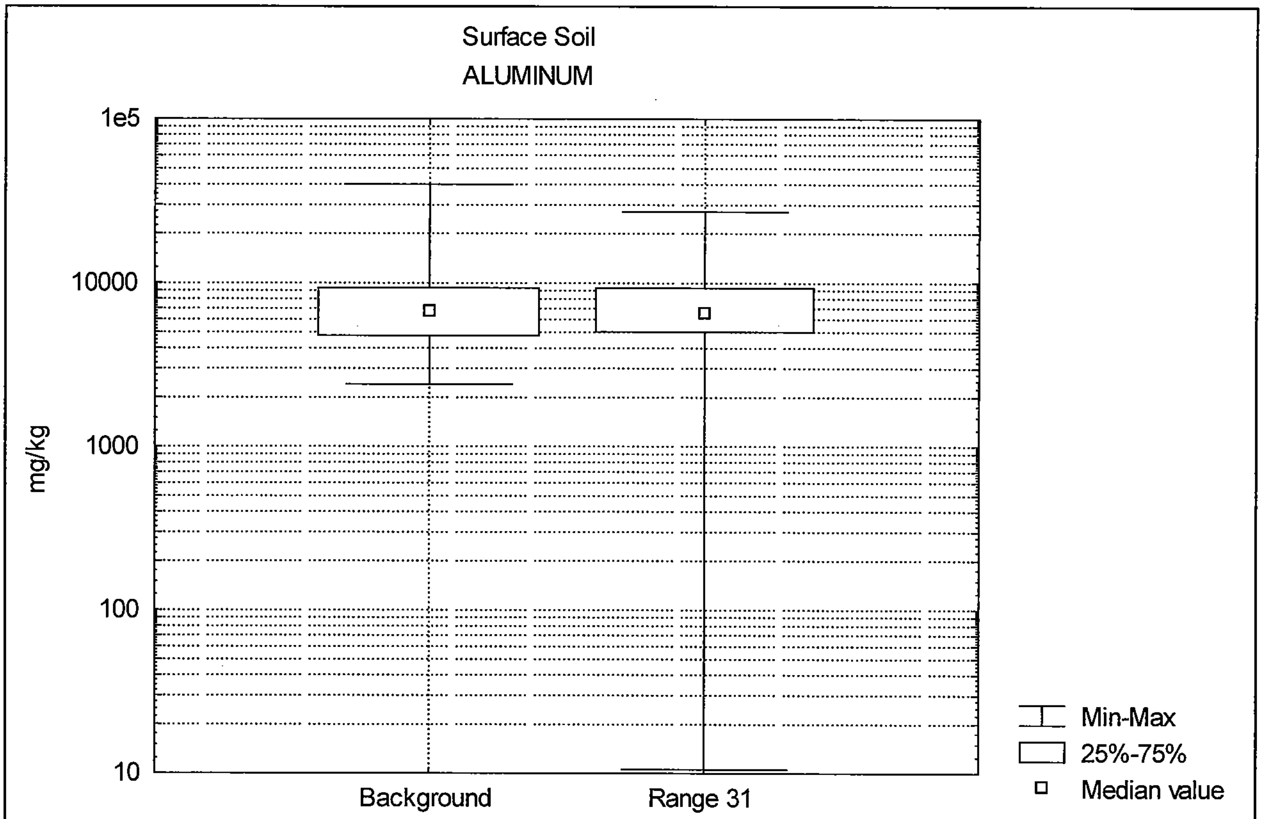
ATTACHMENT 1

Figure 1-1


Surface Soil
ALUMINUM
1e5
10000
1000
100
10
mg/kg
Background
Range 31
Min-Max
25%-75%
Median value

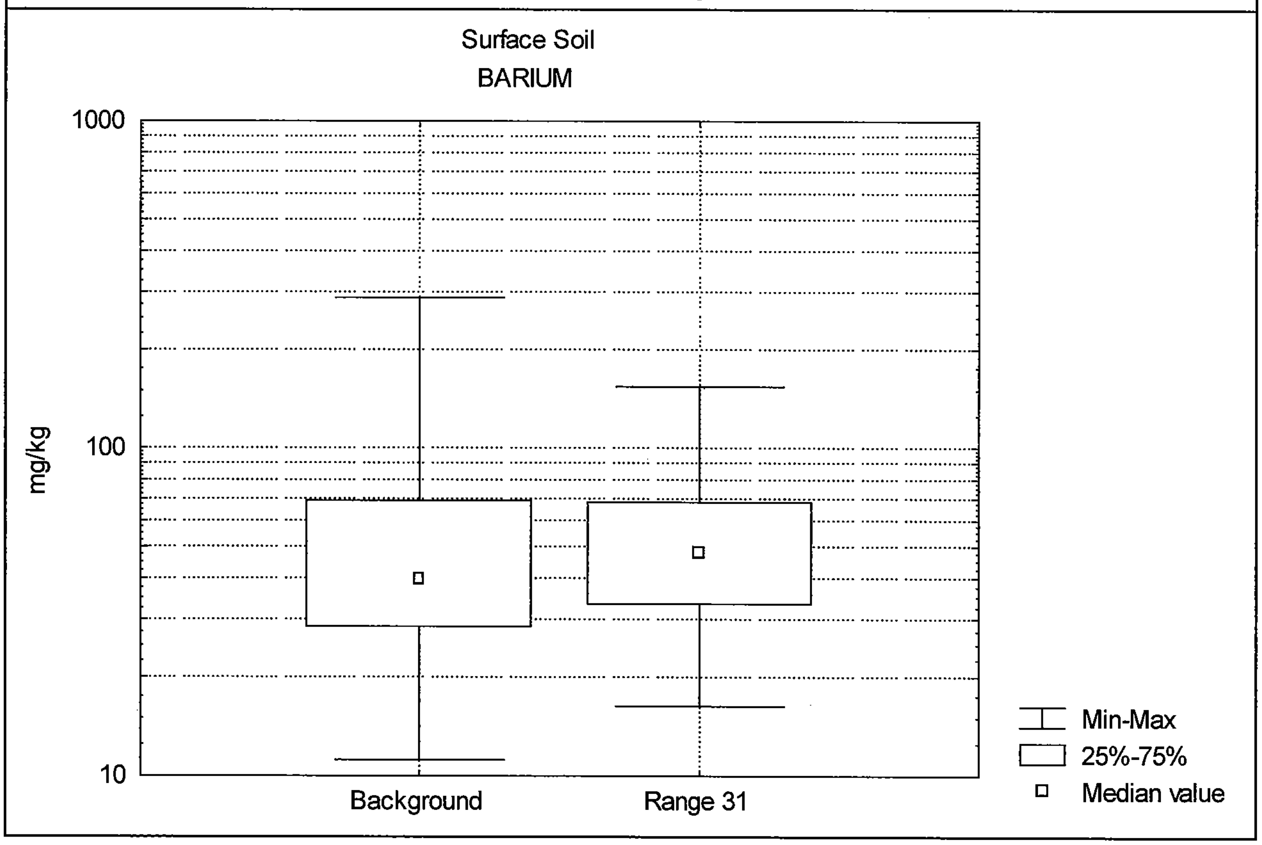

Surface Soil
BARIUM
1000
100
10
mg/kg
Background
Range 31
Min-Max
25%-75%
Median value

Figure 1-2

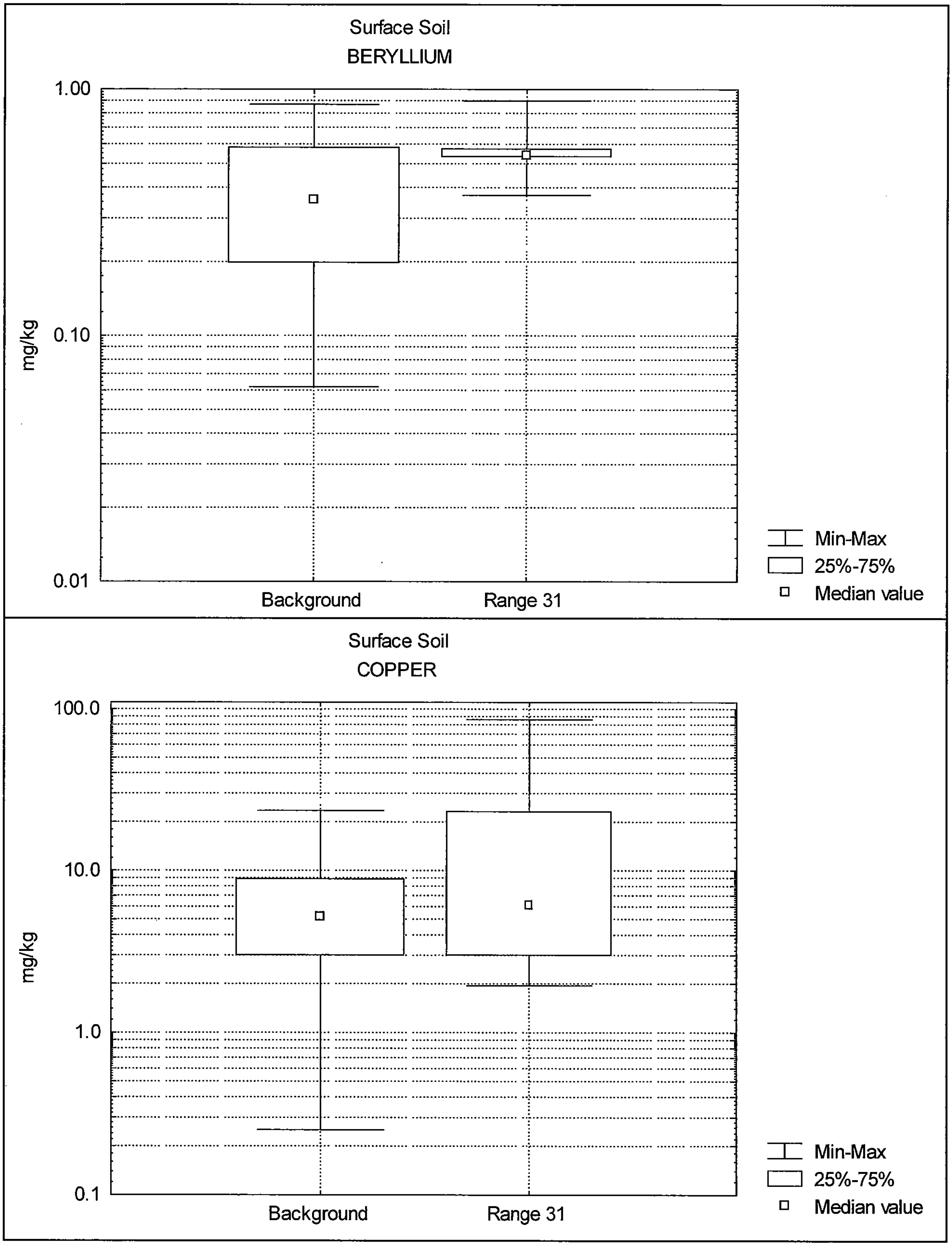
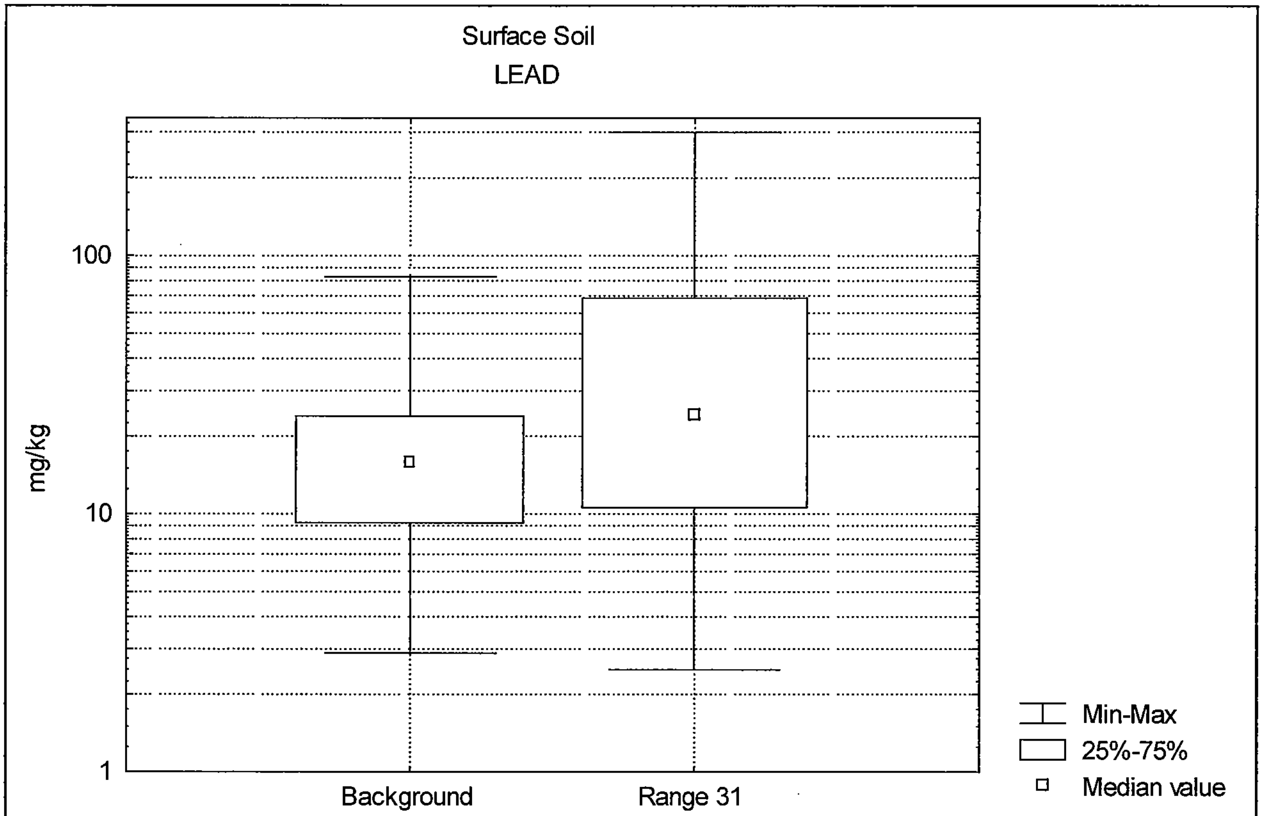

Surface Soil
BERYLLIUM
1.00
0.10
0.01
mg/kg
Background
Range 31
Min-Max
25%-75%
Median value
Surface Soil
COPPER
100.0
10.0
1.0
0.1
mg/kg
Background
Range 31
Min-Max
25%-75%
Median value

Figure 1-3


Surface Soil
LEAD
mg/kg
100
10
1
Background
Range 31
Min-Max
25%-75%
Median value

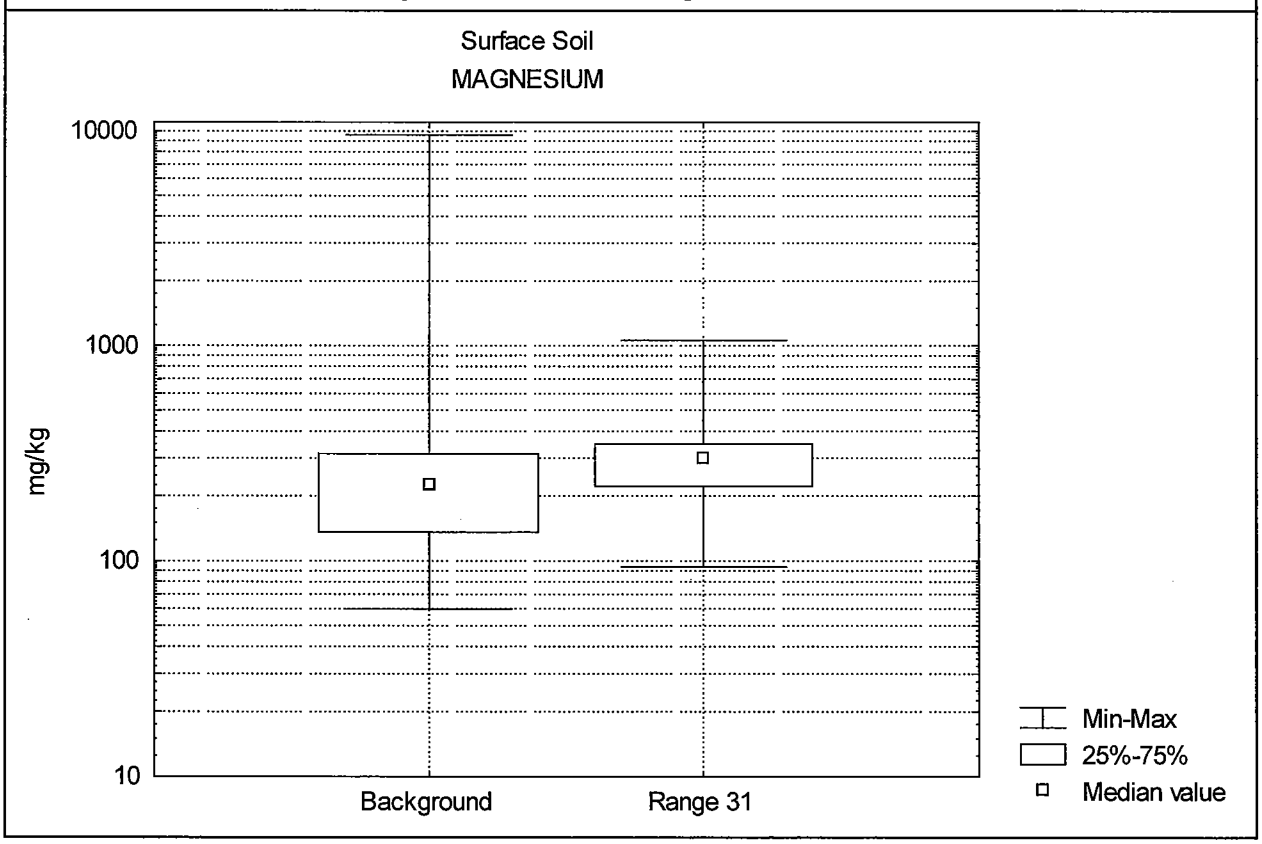

Surface Soil
MAGNESIUM
mg/kg
10000
1000
100
10
Background
Range 31
Min-Max
25%-75%
Median value

Figure 1-4

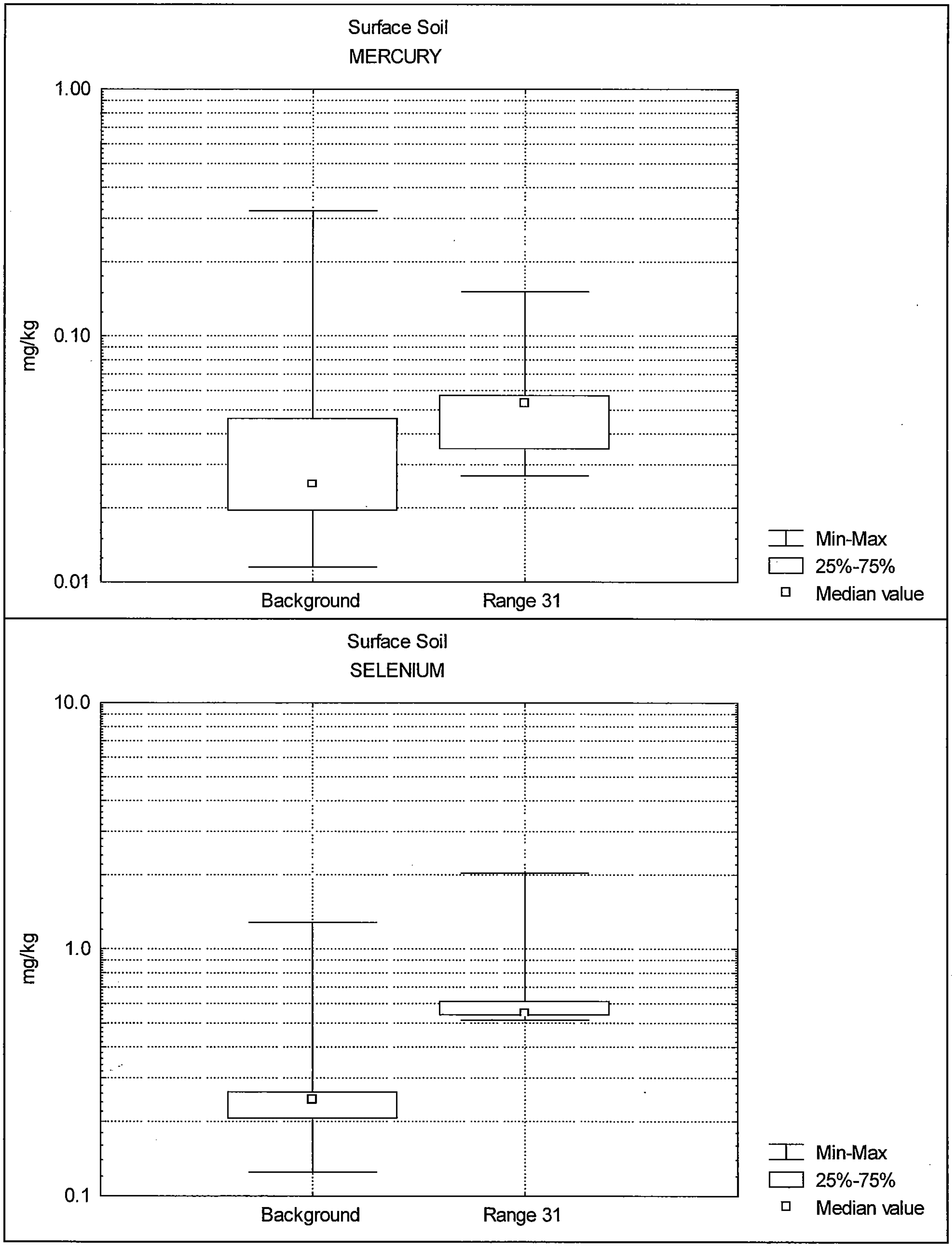

Surface Soil
MERCURY
1.00
0.10
0.01
mg/kg
Background
Range 31
Min-Max
25%-75%
Median value
Surface Soil
SELENIUM
10.0
1.0
0.1
mg/kg
Background
Range 31
Min-Max
25%-75%
Median value

Figure 1-5

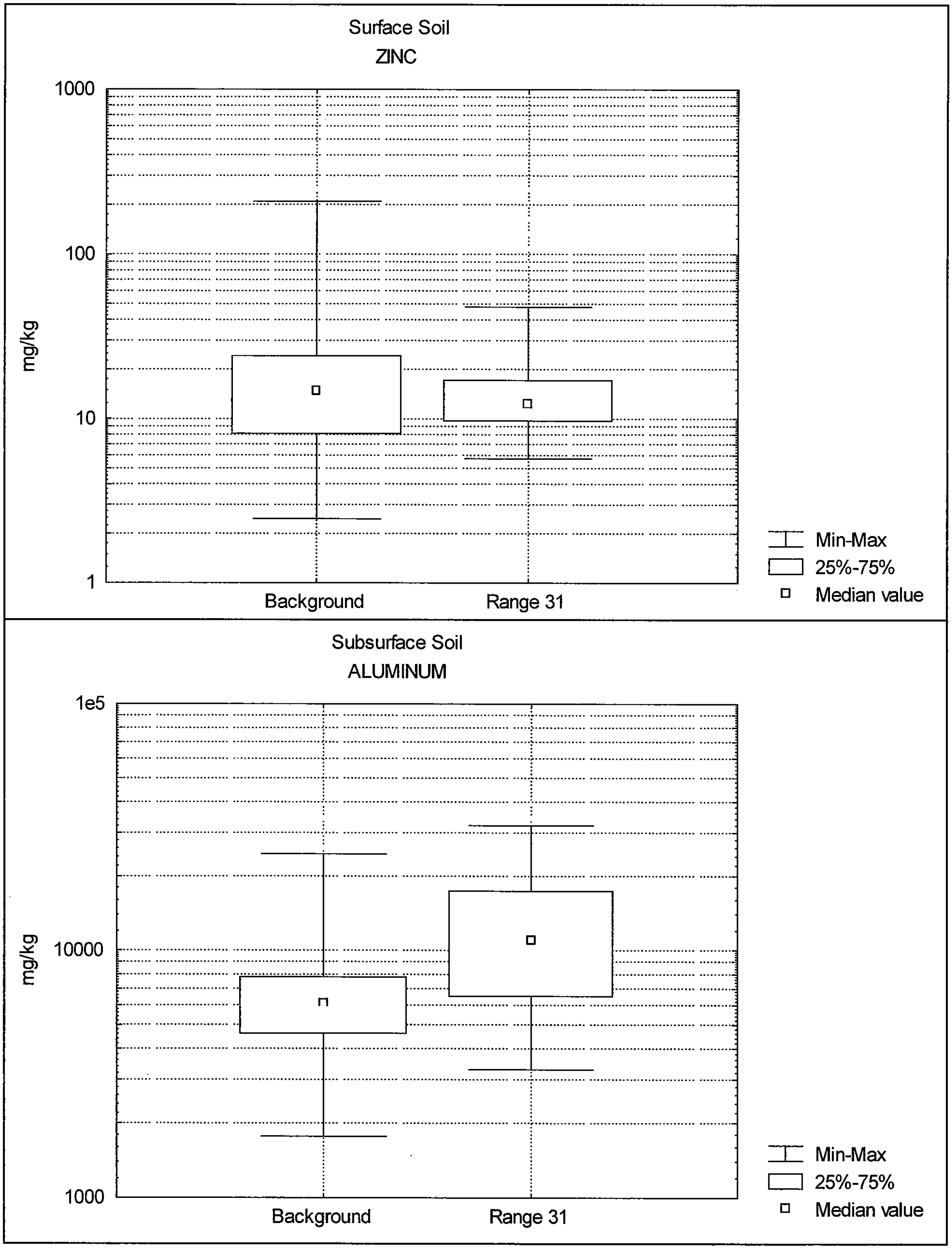

Surface Soil
ZINC
1000
100
10
1
mg/kg
Background
Range 31
Min-Max
25%-75%
Median value
Subsurface Soil
ALUMINUM
1e5
10000
1000
mg/kg
Background
Range 31
Min-Max
25%-75%
Median value

Figure 1-6

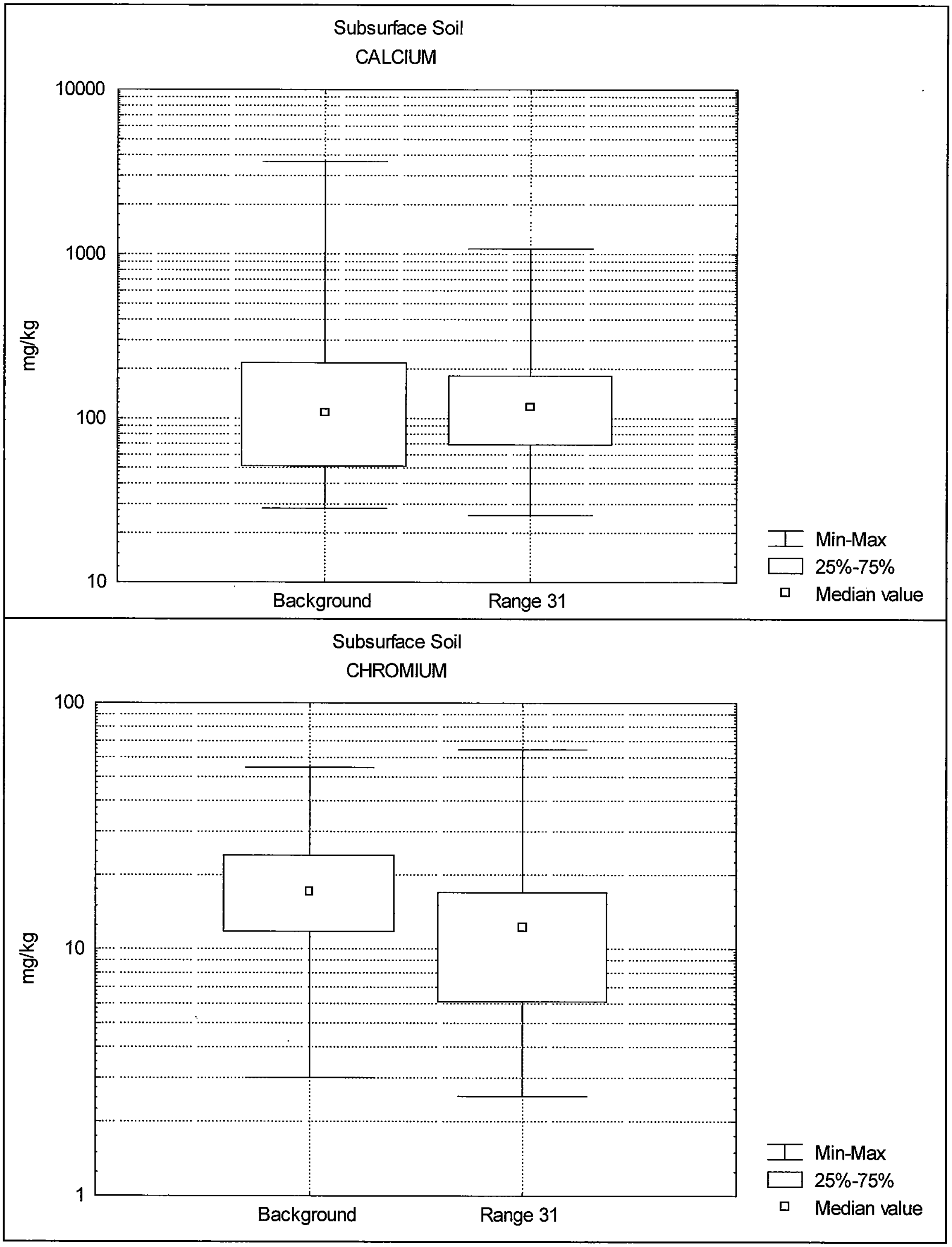
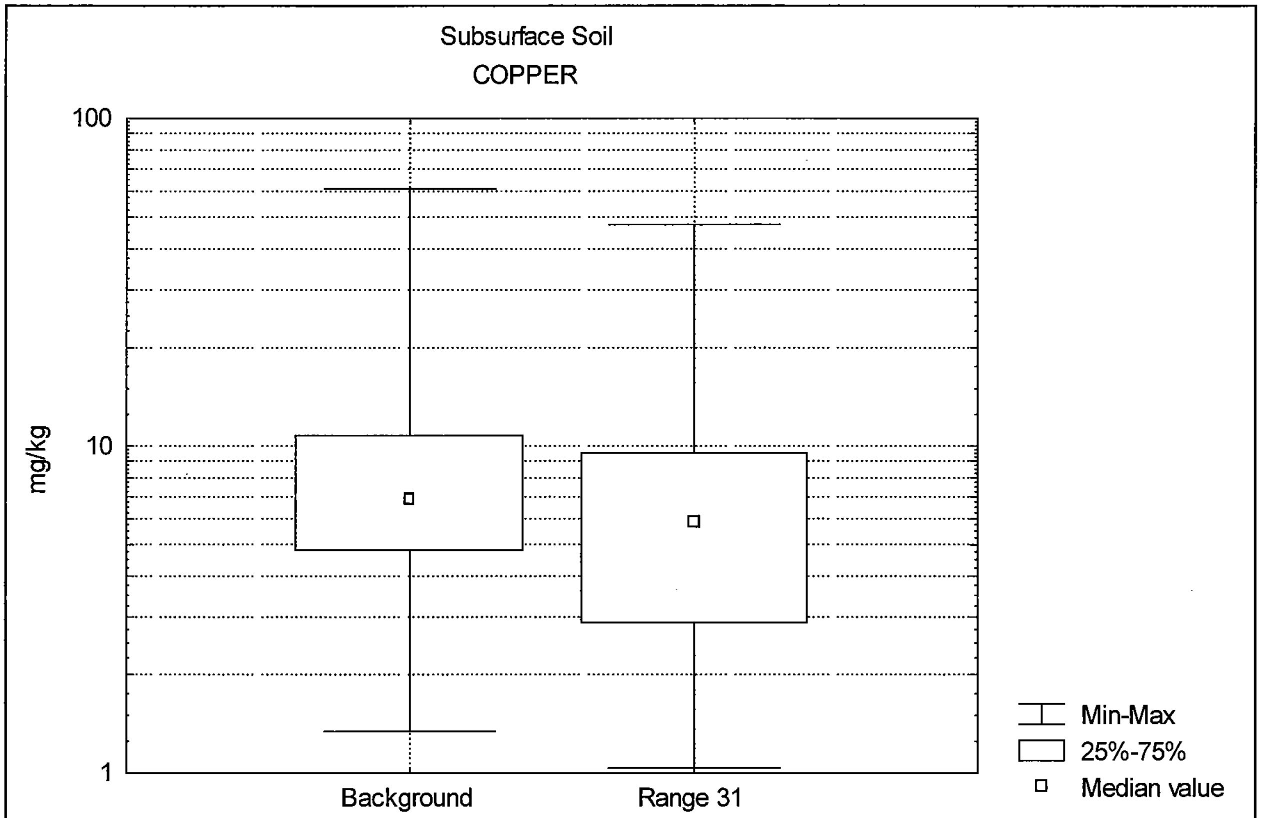
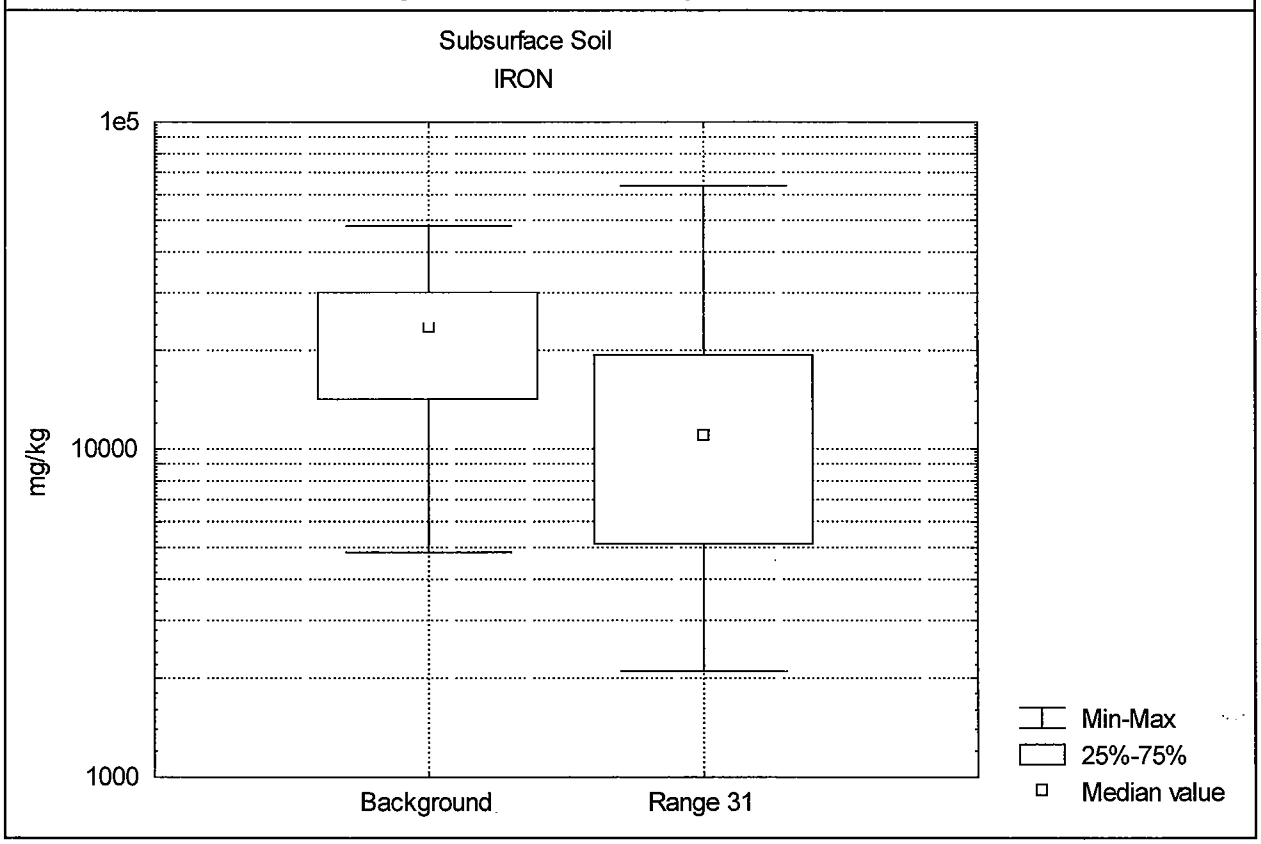

Subsurface Soil
CALCIUM
10000
1000
100
10
mg/kg
Background
Range 31
Min-Max
25%-75%
Median value
Subsurface Soil
CHROMIUM
100
10
1
mg/kg
Background
Range 31
Min-Max
25%-75%
Median value

Figure 1-7

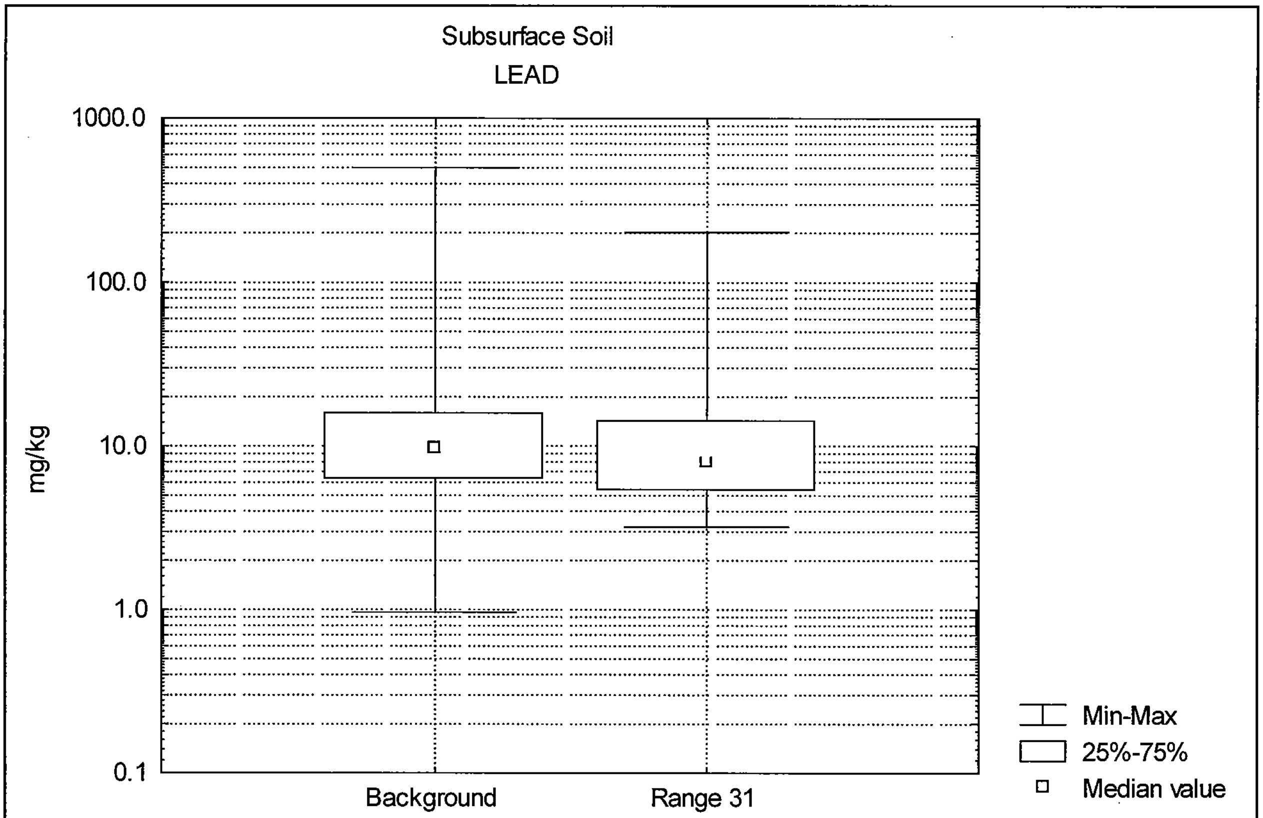


Subsurface Soil
COPPER
100
10
1
mg/kg
Background
Range 31
Min-Max
25%-75%
Median value

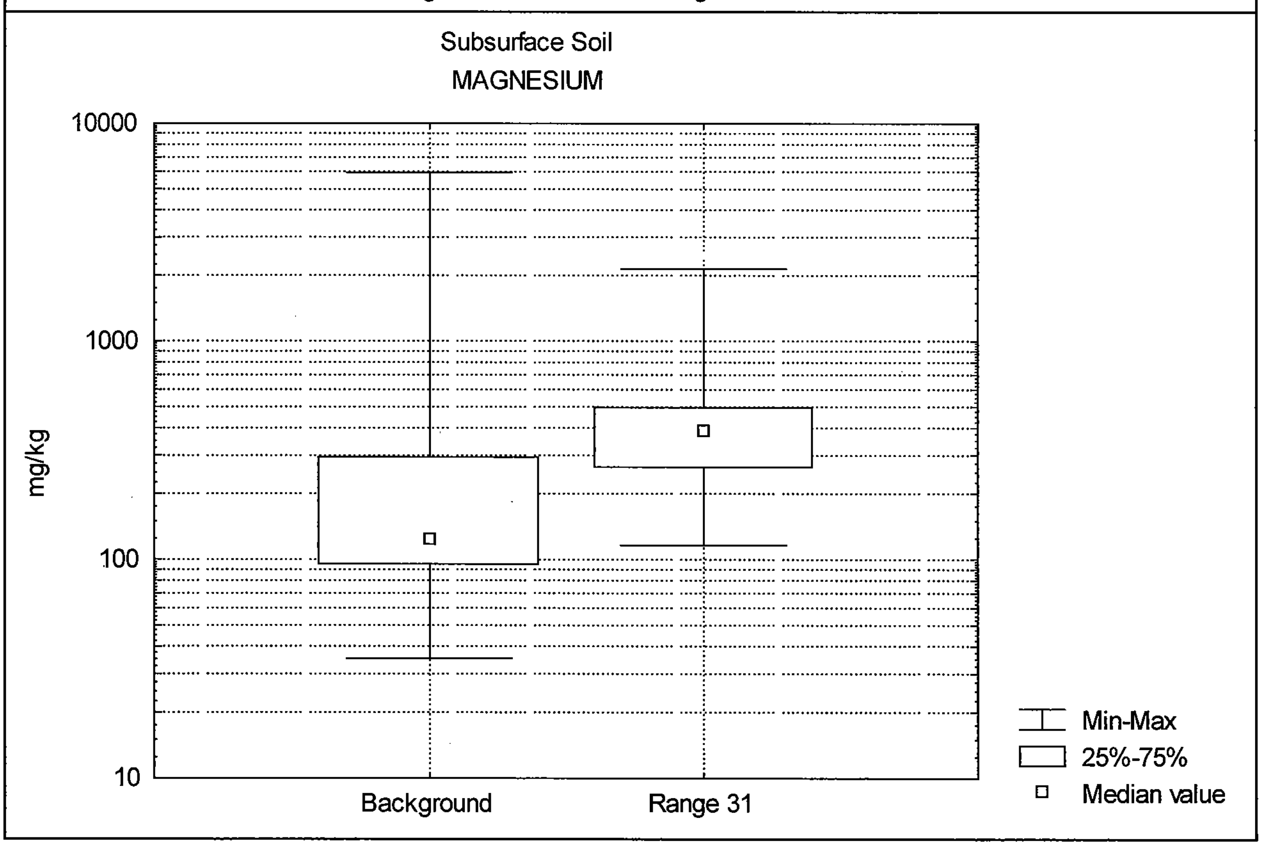


Subsurface Soil
IRON
1e5
10000
1000
mg/kg
Background
Range 31
Min-Max
25%-75%
Median value

Figure 1-8

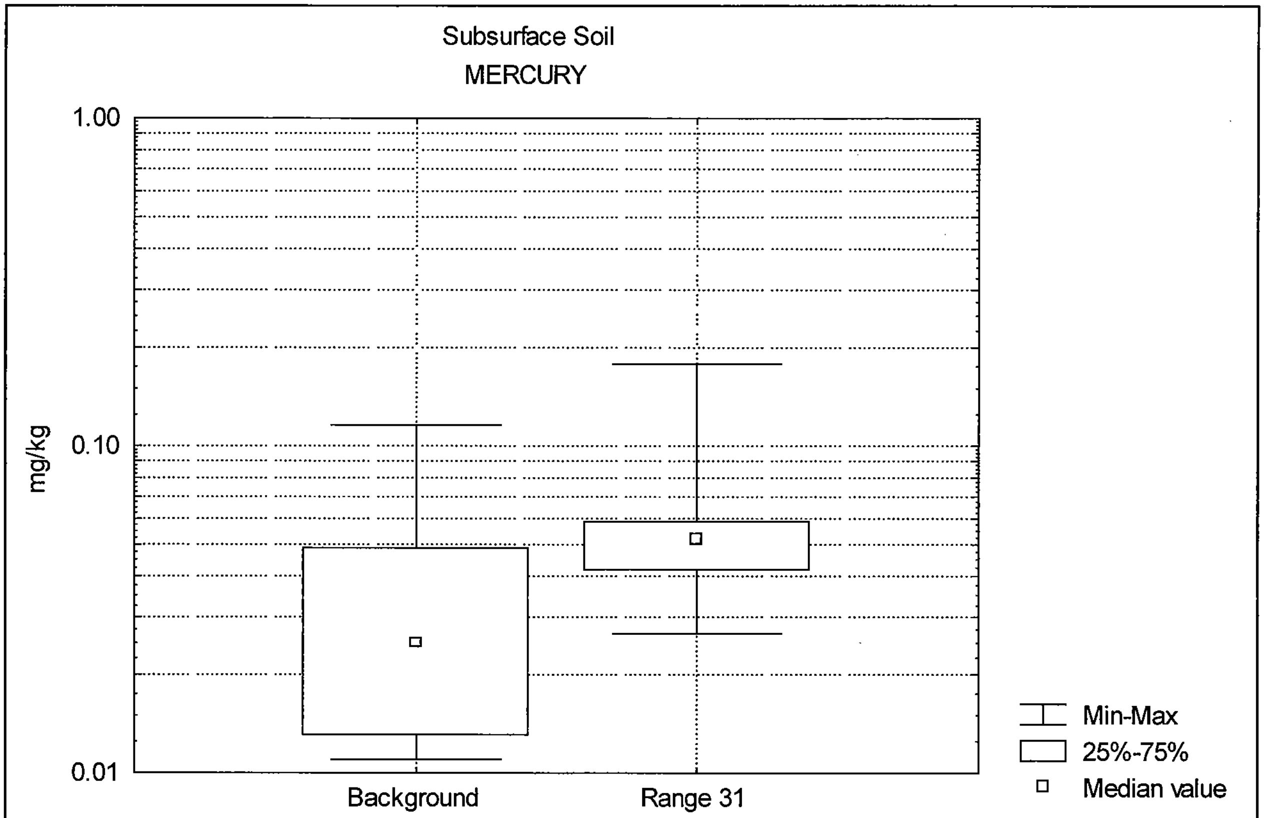


Subsurface Soil
LEAD
1000.0
100.0
10.0
1.0
0.1
mg/kg
Background
Range 31
Min-Max
25%-75%
Median value

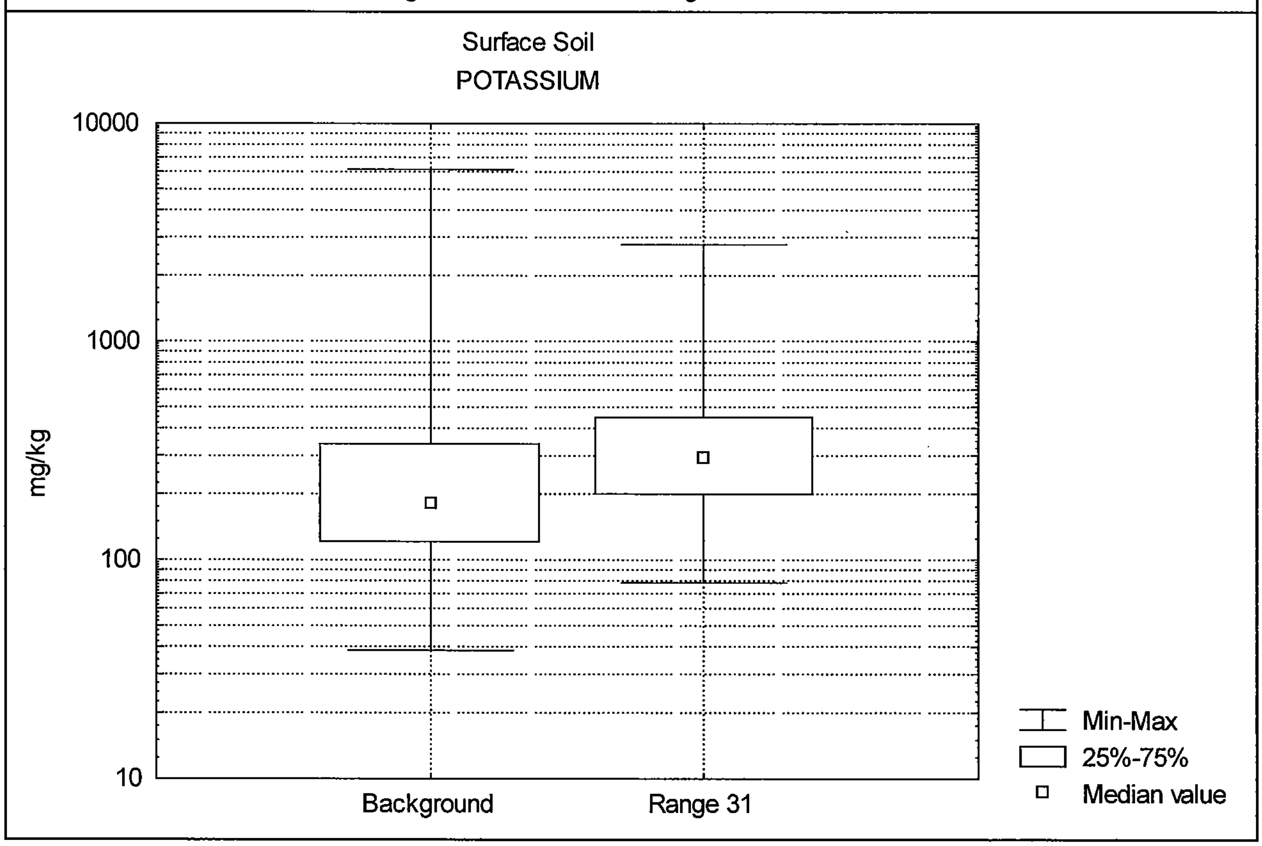


Subsurface Soil
MAGNESIUM
10000
1000
100
10
mg/kg
Background
Range 31
Min-Max
25%-75%
Median value

Figure 1-9

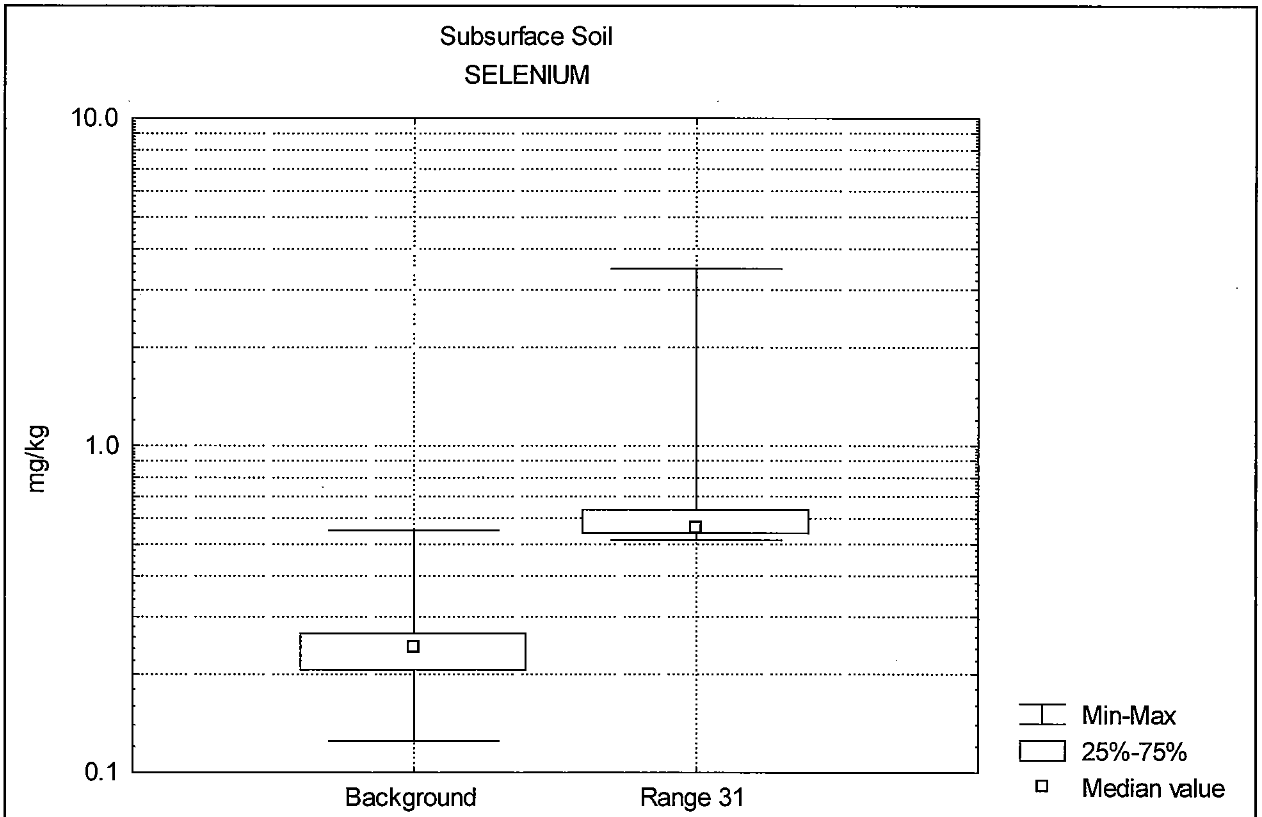


Subsurface Soil
MERCURY
1.00
0.10
0.01
mg/kg
Background
Range 31
Min-Max
25%-75%
Median value

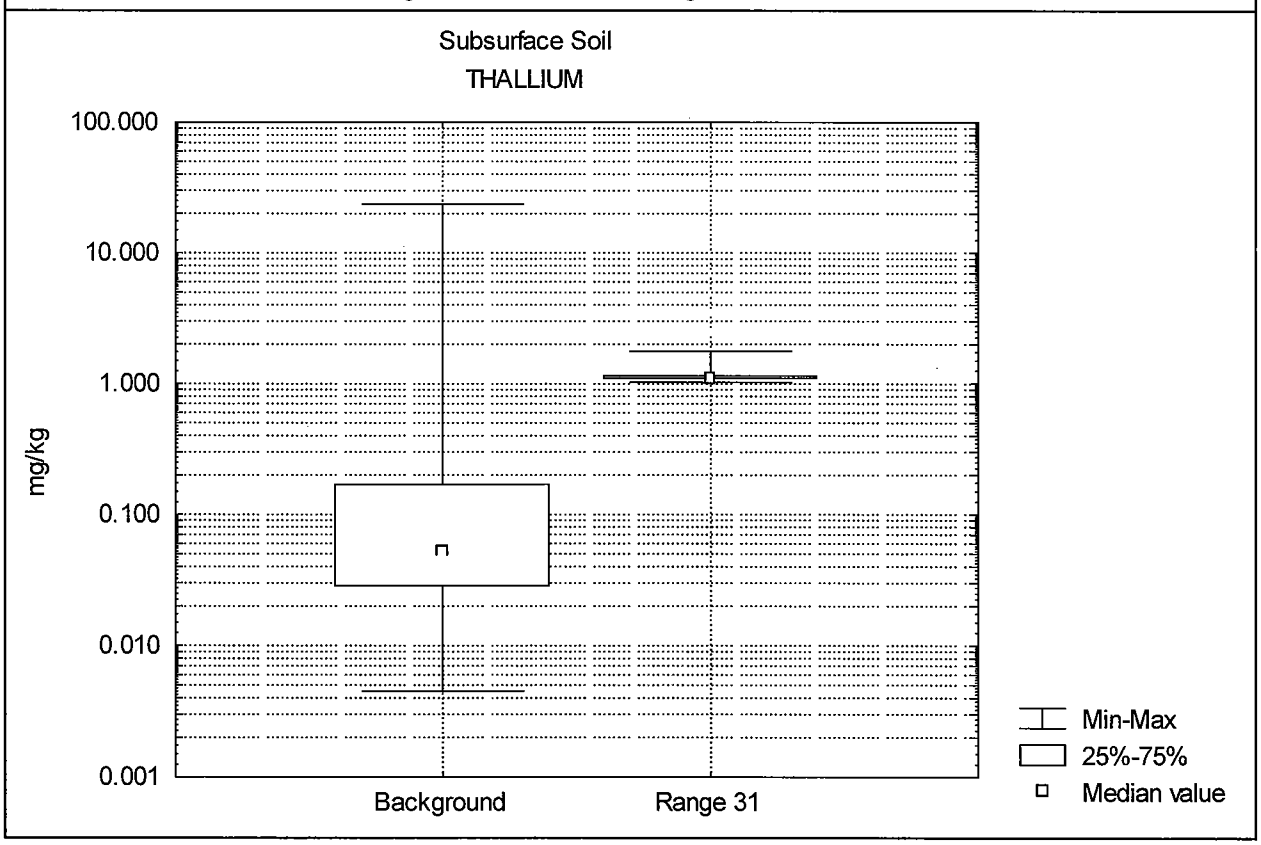


Surface Soil
POTASSIUM
10000
1000
100
10
mg/kg
Background
Range 31
Min-Max
25%-75%
Median value

Figure 1-10

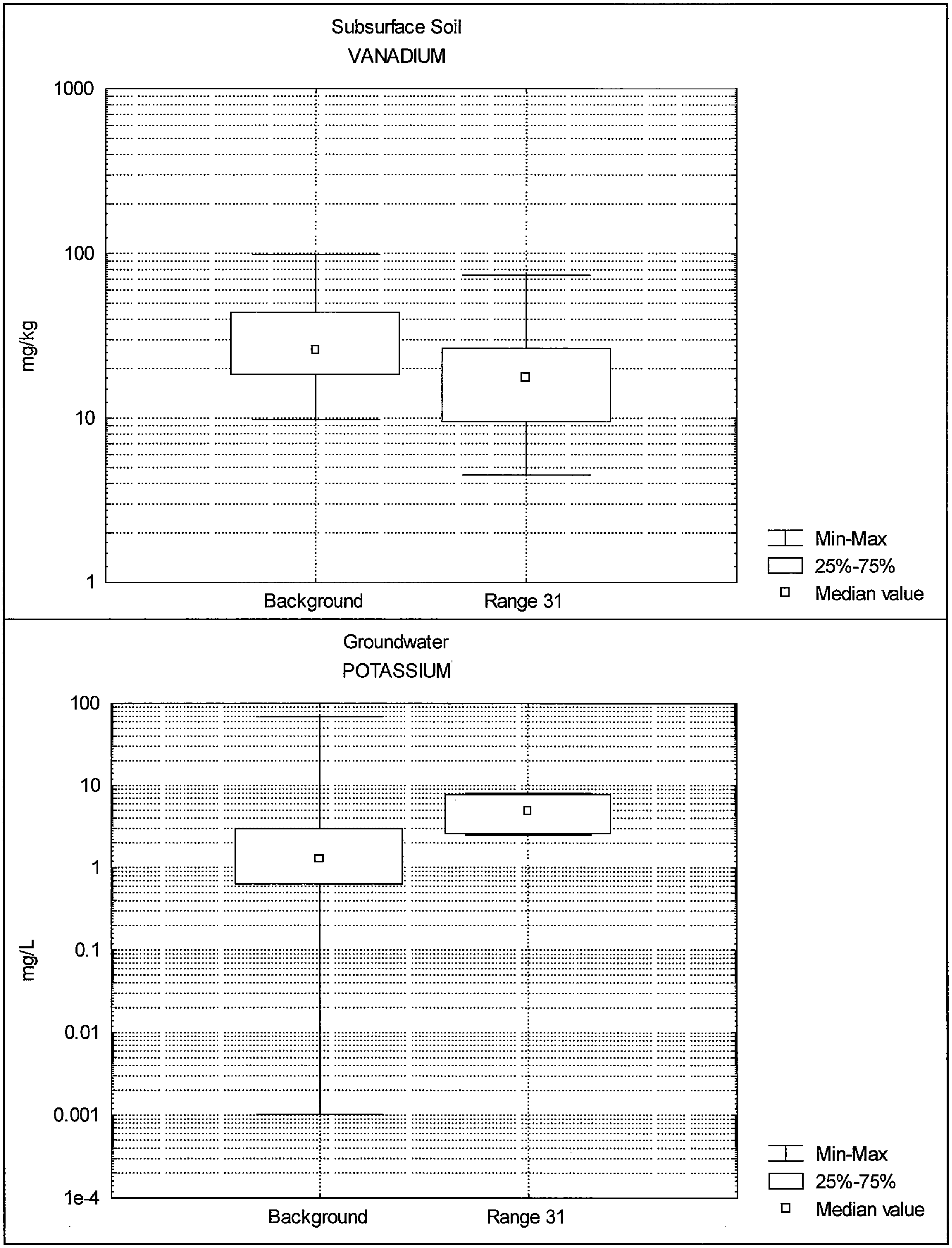


Subsurface Soil
SELENIUM
10.0
1.0
0.1
mg/kg
Background
Range 31
Min-Max
25%-75%
Median value



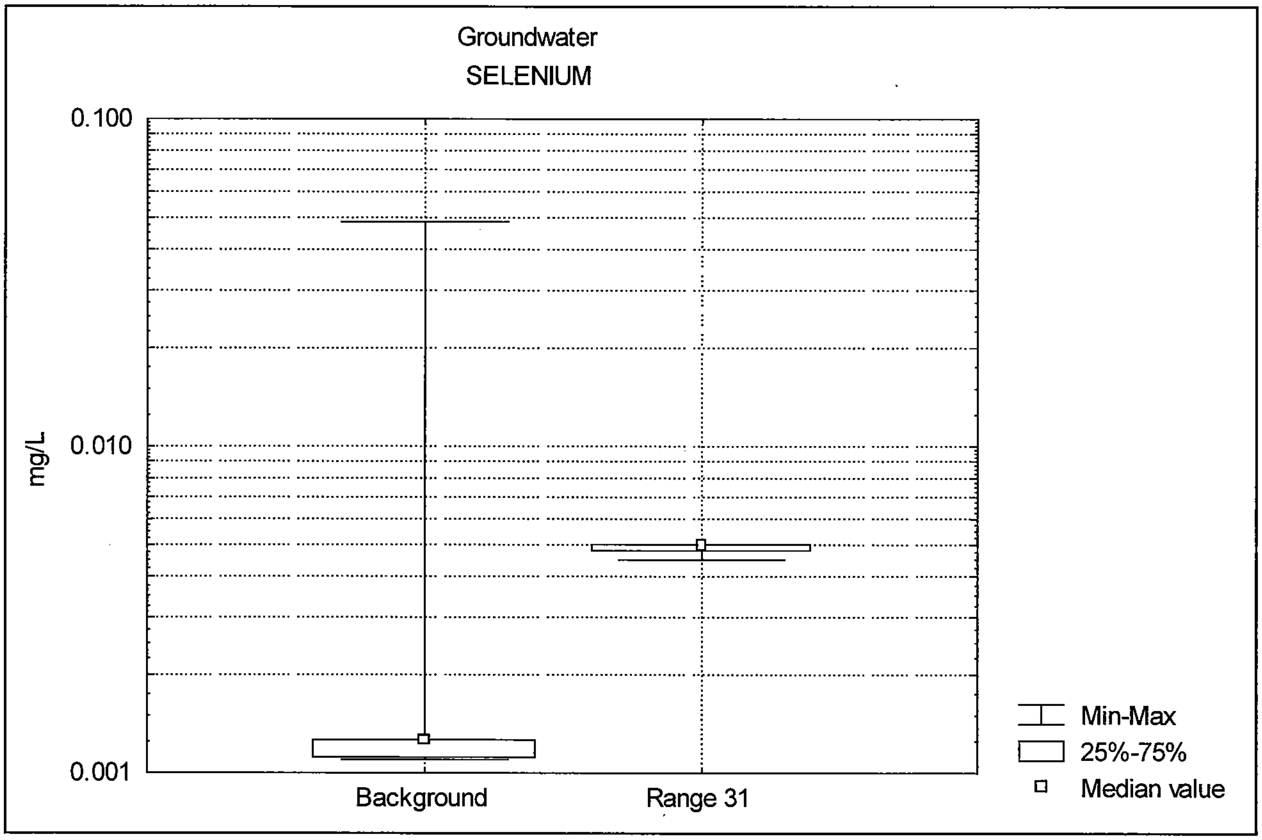
Subsurface Soil
THALLIUM
100.000
10.000
1.000
0.100
0.010
0.001
mg/kg
Background
Range 31
Min-Max
25%-75%
Median value

Figure 1-11



Subsurface Soil
VANADIUM
1000
100
10
1
mg/kg
Background
Range 31
Min-Max
25%-75%
Median value
Groundwater
POTASSIUM
100
10
1
0.1
0.01
0.001
1e-4
mg/L
Background
Range 31
Min-Max
25%-75%
Median value

Figure 1-12



Groundwater
SELENIUM
0.100
0.010
0.001
mg/L
Background
Range 31
Min-Max
25%-75%
Median value

GEOCHEMICAL
(TIER 3)

Geochemical Evaluation of Metals in Soil Range 31, Weapons Demonstration Range and Defendum Field Firing Range No. 2, Parcels 89Q and 215Q Fort McClellan, Alabama

1.0 Introduction

This report provides the results of a geochemical evaluation of inorganic constituents in soil samples from Range 31, Weapons Demonstration Range and Defendum Field Firing Range No. 2, Parcels 89Q and 215Q at Fort McClellan in Calhoun County, Alabama. Six elements in soil failed statistical comparison to background. A geochemical evaluation was performed to determine if the elevated concentrations are naturally occurring or if they contain a component of contamination.

Site samples included in the evaluation consist of 47 surface soil samples (obtained from depths of 0 to 0.5 foot below ground surface [bgs] and 0 to 1 foot bgs) and 42 subsurface soil samples (varying depths from 1 to 4 feet bgs) collected in June and July 2002. Installation-wide background data for TAL metals in soil are provided in the background study report (Science Applications International Corporation, 1998) and are used in the following evaluation.

2.0 Geochemical Evaluation Methodology

Naturally occurring trace element concentrations in environmental media commonly exceed regulatory screening criteria. Trace element distributions in uncontaminated soil tend to have very large ranges (two to three orders of magnitude are not uncommon), and are highly right-skewed, resembling lognormal distributions. These trace elements are naturally associated with specific soil-forming minerals, and the preferential enrichment of a sample with these minerals will result in elevated trace element concentrations. It is thus important to be able to identify these naturally high concentrations and distinguish them from potential contamination.

If an analyte fails statistical comparison to background as described in the "Statistical Comparison of Site and Background Data for Range 31" then a geochemical evaluation is performed to determine if the elevated concentrations are caused by natural processes. The importance of geochemical evaluations in distinguishing between site and background data sets has been recognized in the industry (U.S. Environmental Protection Agency, 1995; Barclift, *et al.*, 2000; U.S. Navy, 2002; Myers and Thorbjornsen, 2004). When properly evaluated, geochemistry can provide mechanistic explanations for apparently high, yet naturally occurring, constituents. Anomalous samples that may represent contamination can also be readily distinguished from uncontaminated samples. This section describes the geochemical evaluation techniques that were employed in the site-to-background comparisons for Range 31.

It should be noted that the geochemical evaluations rely in part on professional judgment and qualitative assessment is a necessary part of the process. Samples that plot off the linear trend on a correlation plot are certainly suspect, but because all uncertainty cannot be eliminated from the evaluation, such plots cannot be construed as definitive proof of contamination. However, anomalous samples should be flagged as suspect and their results used as a basis for further investigation, risk assessment, or remediation, as appropriate. The combination of statistical evaluations (Tiers 1 and 2) and geochemical evaluation (Tier 3) as presented in this appendix is effective in reducing the occurrences of decision errors relative to consideration of statistics or geochemistry alone.

Soil and Sediment. The geochemical evaluation is based on the natural associations of trace elements with specific minerals in the soil or sediment matrix. As an example, arsenic in most uncontaminated oxic soils is almost exclusively associated with iron oxide minerals (Bowell, 1994; Schiff and Weisberg, 1997). (The term "iron oxide" is used here to include oxides, hydroxides, oxyhydroxides, and hydrous oxides of iron.) This association of arsenic with iron oxides is a result of the adsorptive behavior of this particular trace metal in an oxic soil environment. Arsenic is present in oxic soil pore fluid as negatively charged oxyanions ($HAsO_4^{-2}$, $H_2AsO_4^{-}$) (Brookins, 1988). These anions have strong affinities to adsorb on the surfaces of iron oxides, which maintain a strong positive surface charge (Electric Power Research Institute, 1986). If a soil sample has a high percentage of iron oxides, then it is expected to have a proportionally higher concentration of arsenic.

The absolute concentrations of arsenic and iron can vary by several orders of magnitude at a site, but the arsenic/iron ratios in the samples are usually quite constant as long as no contamination is present (Daskalakis and O'Connor, 1995). If a sample has some naturally occurring arsenic plus additional arsenic from an herbicide or some other source, then it will have an anomalously high ratio relative to the other uncontaminated samples. These ratios thus serve as a powerful technique for identifying contaminated samples.

The evaluation includes the generation of plots in which detected arsenic concentrations in a set of samples are plotted on the y-axis, and the corresponding detected iron concentrations are plotted on the x-axis. The slope of a best-fit line through the samples is equal to the average arsenic/iron background ratio. If the samples with the highest arsenic concentrations plot on the same linear trend as the other samples, then it is most probable that the elevated concentrations are natural, and are caused by the preferential enrichment of iron oxides in those samples. If the site samples with elevated arsenic concentrations plot above the trend displayed by the uncontaminated samples, then there is evidence that those samples have an excess contribution of arsenic, and contamination may be indicated.

Each trace element is associated with one or more minerals in the soil matrix. Vanadium and selenium, along with arsenic, form anionic species in solution and are associated with iron oxides, which maintain a positive surface charge. Divalent metals such as barium, cadmium, lead, and zinc tend to form cationic species in solution and are attracted to clay mineral surfaces, which maintain a negative surface charge. These trace elements would be evaluated against aluminum, which is a major component of clay minerals. Manganese oxides also have an affinity to adsorb divalent cations such as barium, cobalt, and lead (Kabata-Pendias, 2001). These trace elements would be evaluated against manganese.

3.0 Results of the Geochemical Evaluation of Multiple Elements in Soil

This section presents the results of the geochemical evaluation of copper, lead, magnesium, mercury, potassium, and selenium in soil samples from Range 31. Correlation plots are provided in Attachment 1.

Copper

Copper in soil has an affinity to adsorb on the surfaces of minerals such as clays and iron oxide minerals (Kabata-Pendias, 2001). The background samples form a linear trend with a positive slope in a plot of copper versus iron (Figure 1). Many of the site samples lie on the background trend, but many other site samples exhibit anomalously high Cu/Fe ratios and lie above the linear trend. Copper, along with zinc, is a primary component of shell casings and jackets (Interstate Technology and Regulatory Council, 2003), so copper contamination would be expected at firing-range sites such as Range 31. Lead is a known contaminant at firing ranges; a plot of copper versus lead reveals that the samples with elevated copper also have high lead content (Figure 2). This suggests that copper and lead are co-contaminants in site soil.

Based on the comparison to background samples in Figure 1, the site samples with copper concentrations of 23.1 mg/kg and higher exhibit anomalously high Cu/Fe ratios and most likely contain a component of contamination. This includes twelve surface soil samples and one subsurface soil sample. Table 1 lists the site samples with anomalous element concentrations, and provides both the sample identification numbers and corresponding sample location codes.

Table 1

Samples With Anomalous Element Concentrations
Range 31
Fort McClellan, Alabama

Medium	Sample Location	Sample Number	Element(s)
Surface Soil	HR-89Q-GP03	QU0006	Copper
Surface Soil	HR-89Q-GP04	QU0008	Copper, Lead
Surface Soil	HR-89Q-GP09	QU0019	Copper, Lead
Surface Soil	HR-89Q-GP10	QU0022	Copper, Lead
Surface Soil	HR-89Q-GP12	QU0026	Copper, Lead
Surface Soil	HR-89Q-GP13	QU0029	Copper, Lead
Surface Soil	HR-89Q-GP23	QU0050	Lead
Surface Soil	HR-89Q-GP24	QU0052	Lead
Surface Soil	HR-89Q-GP27	QU0058	Copper, Lead
Surface Soil	HR-89Q-GP36	QU0077	Lead
Surface Soil	HR-89Q-MW04	QU0088	Copper, Lead
Surface Soil	HR-89Q-MW05	QU0090	Copper, Lead
Surface Soil	HR-89Q-DEP01	QU0093	Copper, Lead
Surface Soil	HR-89Q-DEP02	QU0094	Lead
Surface Soil	HR-89Q-DEP03	QU0096	Copper, Lead
Surface Soil	HR-89Q-DEP05	QU0098	Copper, Lead, Mercury
Subsurface Soil	HR-89Q-GP09	QU0021	Lead
Subsurface Soil	HR-89Q-GP12	QU0028	Copper, Lead

Conclusion
Copper concentrations in multiple site soil samples are anomalously high and reflect site-related contamination (Table 1).

Lead

As discussed in Section 2.0, manganese oxides have an affinity to adsorb divalent cations such as barium, cobalt, and lead (Kabata-Pendias, 2001). The background samples form a linear trend with a positive slope in a plot of lead versus manganese (Figure 3). Some of the site samples lie on the background trend, but many other site samples exhibit anomalously high Pb/Mn ratios and lie above the linear trend. Elevated lead in these samples should be considered suspect. Lead is an expected contaminant at firing range sites such as Range 31, due to its presence in bullets and bullet fragments.

Based on the comparison to background samples in Figure 3, the site samples with lead concentrations of 68.3 mg/kg and higher exhibit anomalously high Pb/Mn ratios and most likely contain a component of contamination. In addition, the following four samples contain anomalously high Pb/Mn ratios, and should be considered suspect: surface soil samples QU0050 (31.7 mg/kg Pb), QU0098 (39.1 mg/kg Pb), and QU0094 (39.5 mg/kg Pb) and subsurface soil sample QU0021 (41.8 mg/kg Pb). Table 1 lists the site samples with anomalous element concentrations, and provides both the sample identification numbers and corresponding sample location codes.

Conclusion
Lead concentrations in multiple site soil samples are anomalously high and reflect site-related contamination (Table 1).

Magnesium

Magnesium is a common component of minerals such as clays and micas, which contain aluminum as a primary constituent, so positive correlations between magnesium and aluminum concentrations in soil are often observed. A plot of magnesium versus aluminum reveals a generally linear trend for most of the background samples, and the all of the site samples lie on this trend (Figure 4). The site samples with high magnesium concentrations also exhibit proportionally higher aluminum content and lie on the background trend. These observations indicate a natural source for the elevated magnesium in the site samples.

Conclusion
Magnesium detected in the site soil samples is naturally occurring.

Mercury

Mercury concentrations in soil are commonly controlled through organic complex formation (Kabata-Pendias, 2001), so weak correlations between mercury and iron or mercury and aluminum are often observed, even in uncontaminated soil samples. The background samples form a weak linear trend with a positive slope in a plot of mercury versus aluminum (Figure 5). Most of the site samples lie on this trend. Mercury in these site samples is associated with clays at ratios consistent with those of the background samples, and is natural. Site surface soil sample QU0098 (location HR-89Q-DEP05), however, contains the highest mercury concentration of the site surface soil samples (0.151 mg/kg) but only low aluminum (as well as only low iron and manganese), and lies above the background trend. Elevated mercury in this sample should be considered suspect. It should be noted that any contamination, if present, is minor; there are two background samples with higher mercury concentrations (0.177 and 0.322 mg/kg) than that of sample QU0098.

Conclusion
The mercury concentration in surface soil sample QU0098 is anomalously high relative to the major elements, and may contain a component of contamination. Mercury detected in the other site soil samples is naturally occurring.

Potassium
Potassium is a common component of soil-forming minerals such as clays, which contain aluminum as a primary constituent, so positive correlations between potassium and aluminum concentrations in soil are often observed. A plot of potassium versus aluminum is provided in Figure 6. The site surface soil samples are linear and they all lie on the trend formed by most of the background samples. Most of the site subsurface soil samples also lie on the background trend. The subsurface sample with the highest potassium (2,780 mg/kg) lies slightly above the linear trend, but it is well below the background maximum of 6,150 mg/kg. Potassium in the site samples is natural.

Conclusion
Potassium detected in the site soil samples is naturally occurring.

Selenium
As explained in Section 2.0, selenium has a strong affinity to adsorb on iron oxides in oxic soils, so a positive correlation between selenium and iron is expected for uncontaminated soil samples under these conditions. A plot of selenium versus iron is provided in Figure 7. The site samples form a linear trend with a positive slope ($R^2 = 0.93$ and 0.96 for the surface and subsurface intervals, respectively), and one of the two background samples with detectable selenium lies on this trend. The site sample with the highest selenium concentration also contains the highest iron, and lies on the trend established by the other samples. These observations indicate that selenium in the samples is associated with iron oxides at a relatively constant ratio, and is natural.

Conclusion
Selenium detected in the site soil samples is naturally occurring.

4.0 Summary
Geochemical evaluation indicates that all of the magnesium, potassium, and selenium concentrations detected in the Range 31 surface and subsurface soil samples are naturally occurring. The mercury concentration in surface soil sample QU0098 is anomalously high relative to the major elements, and may contain a component of contamination. Mercury detected in the other surface soil samples and all of the subsurface soil samples is naturally

occurring. Copper and lead have anomalously high concentrations in both the surface and subsurface soil intervals, and these concentrations should be considered suspect. A list of the samples that contain anomalous element concentrations is provided in Table 1.

5.0 References

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ATTACHMENT 1

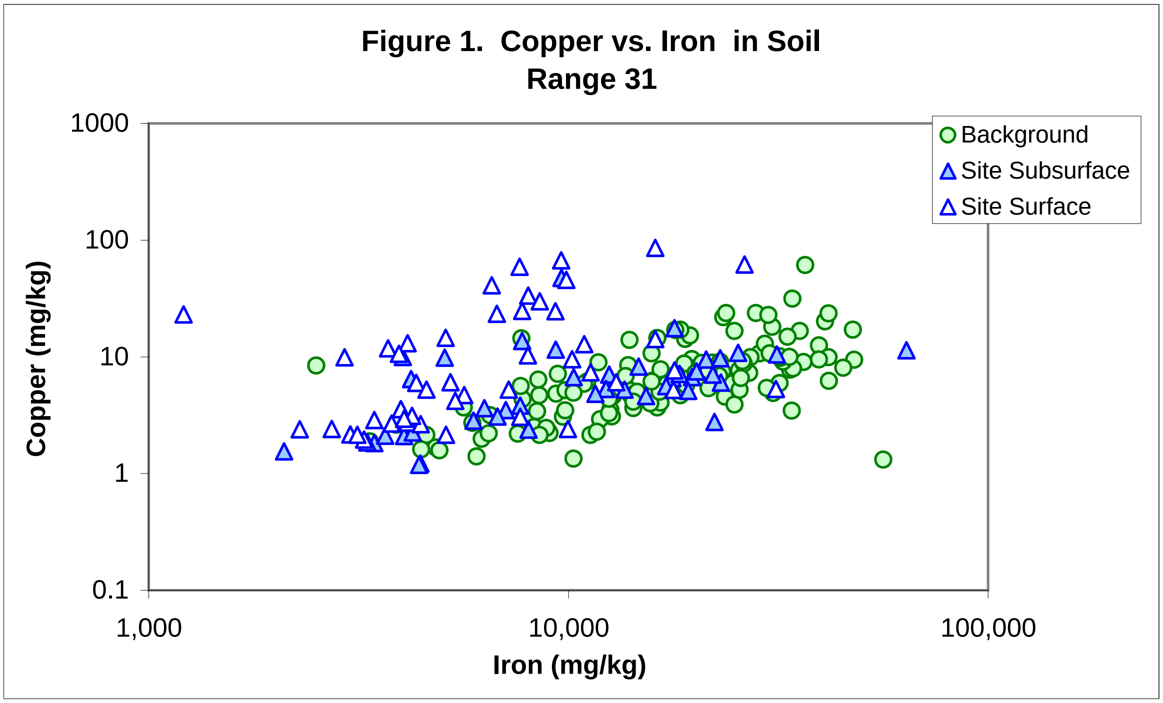
Figure 1. Copper vs. Iron in Soil
Range 31
Copper (mg/kg)
1000
100
10
1
0.1
1,000
10,000
100,000
Iron (mg/kg)
Background
Site Subsurface
Site Surface

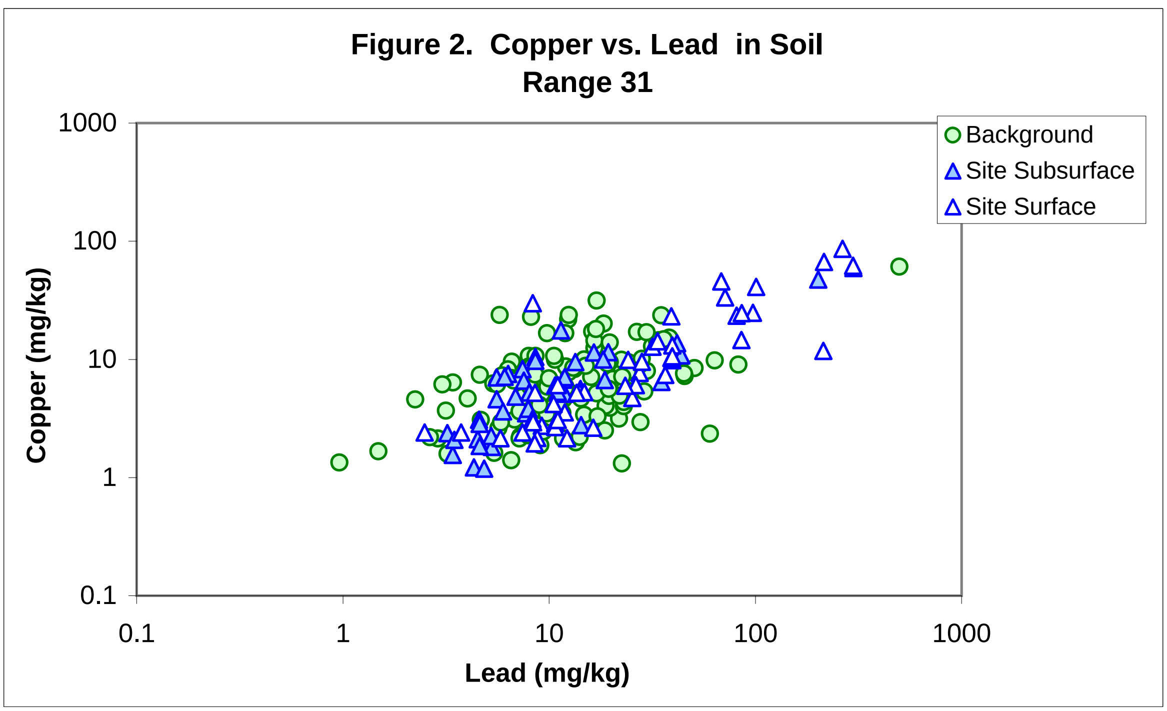
Figure 2. Copper vs. Lead in Soil
Range 31
Copper (mg/kg)
1000
100
10
1
0.1
0.1
1
10
100
1000
Lead (mg/kg)
Background
Site Subsurface
Site Surface

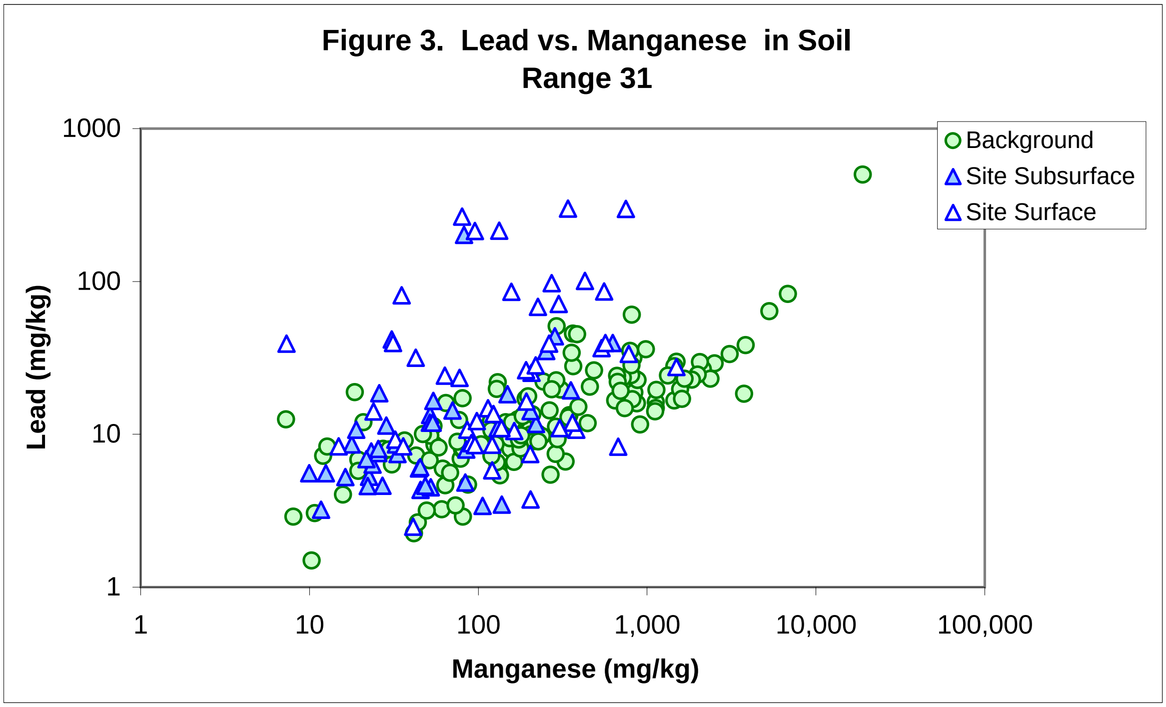

Figure 3. Lead vs. Manganese in Soil
Range 31
Background
Site Subsurface
Site Surface
Lead (mg/kg)
1000
100
10
1
1
10
100
1,000
10,000
100,000
Manganese (mg/kg)

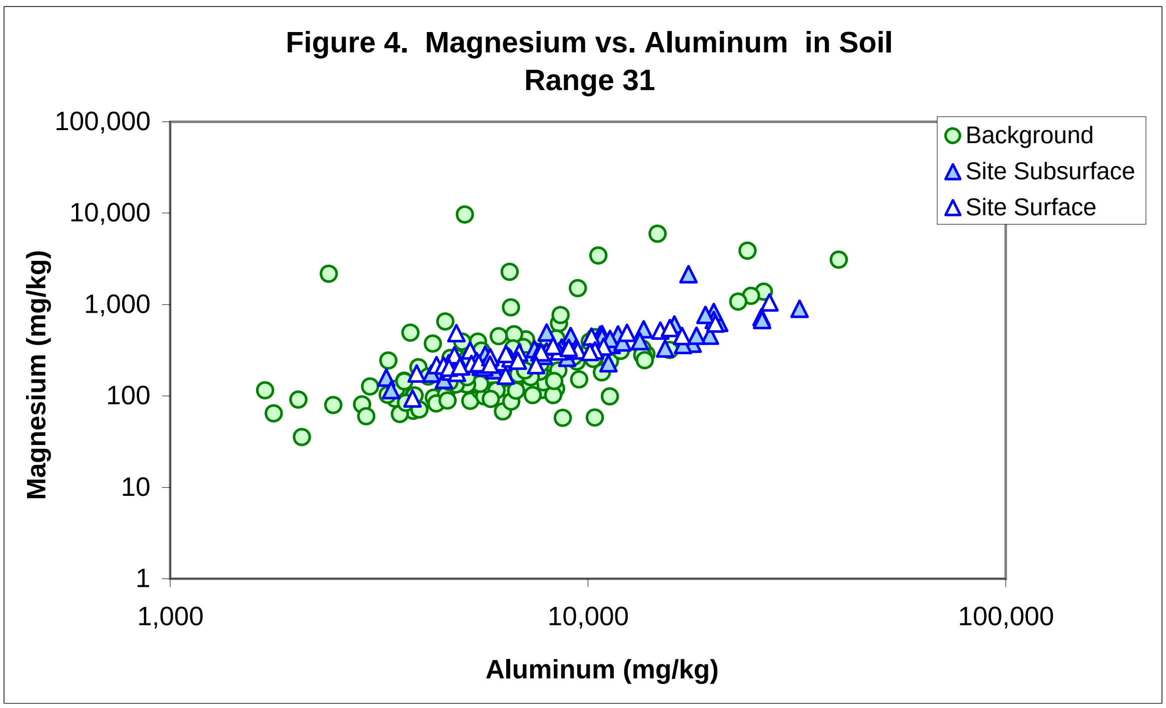

Figure 4. Magnesium vs. Aluminum in Soil
Range 31
Background
Site Subsurface
Site Surface
Magnesium (mg/kg)
100,000
10,000
1,000
100
10
1
1,000
10,000
100,000
Aluminum (mg/kg)

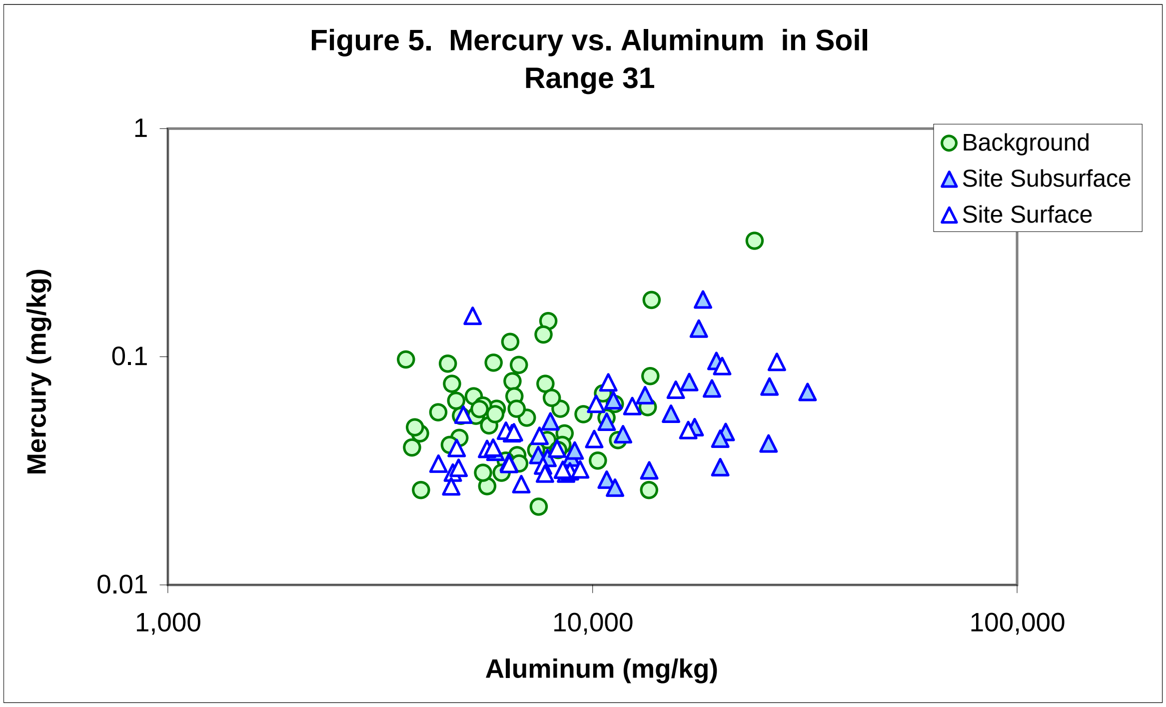

Figure 5. Mercury vs. Aluminum in Soil
Range 31
Mercury (mg/kg)
1
0.1
0.01
1,000
10,000
100,000
Aluminum (mg/kg)
Background
Site Subsurface
Site Surface

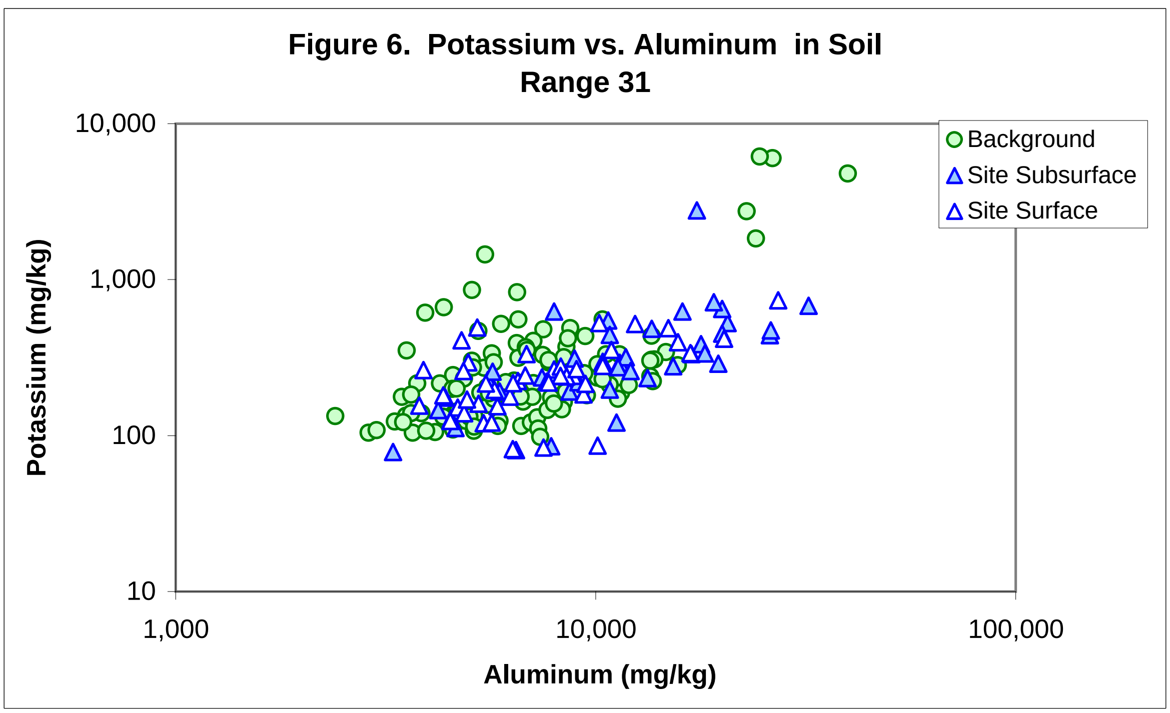

Figure 6. Potassium vs. Aluminum in Soil
Range 31
Potassium (mg/kg)
10,000
1,000
100
10
1,000
10,000
100,000
Aluminum (mg/kg)
Background
Site Subsurface
Site Surface

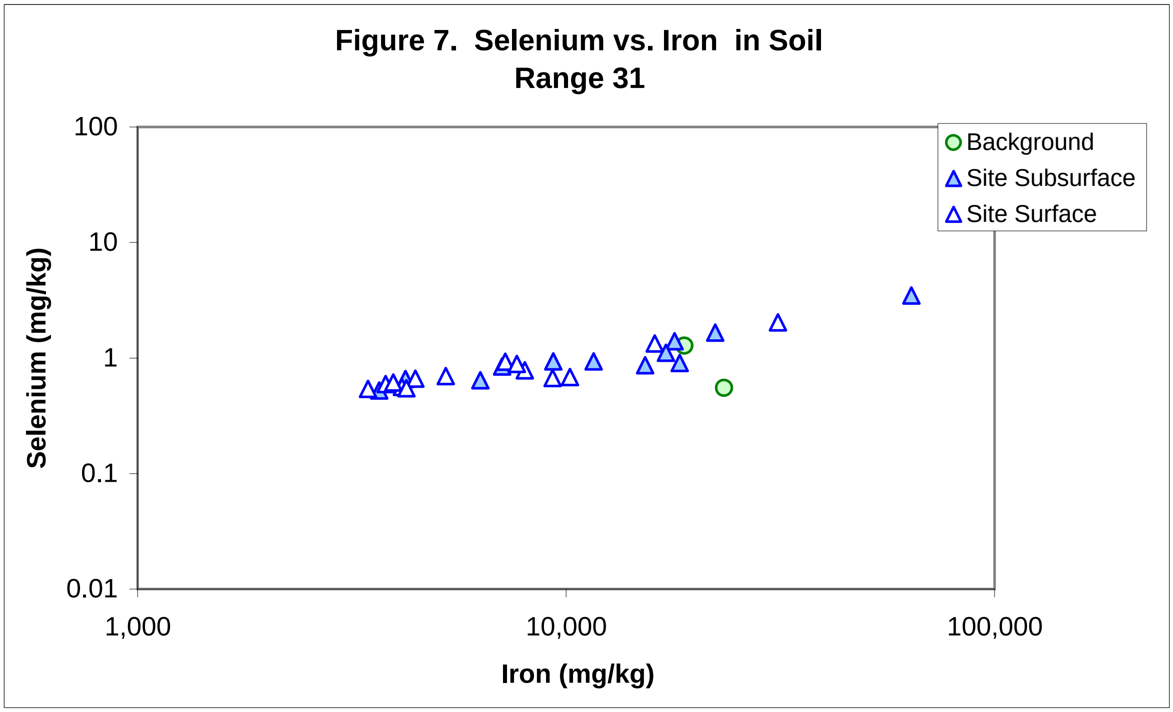
Figure 7. Selenium vs. Iron in Soil
Range 31
Selenium (mg/kg)
100
10
1
0.1
0.01
1,000
10,000
100,000
Iron (mg/kg)
Background
Site Subsurface
Site Surface

RESPONSE TO COMMENTS

Response to Alabama Department of Environmental Management Comments
Draft Site Investigation Report, Range 31: Weapons Demonstration Range,
Parcel 89Q-X and Former Defendum Field Firing Range No. 2, Parcel 215Q
Fort McClellan, Calhoun County, Alabama (dated February 2003)

Comments from Stephen A. Cobb, Chief, Governmental Hazardous Waste Branch, ADEM Land Division, dated May 1, 2003.

General Comments

Comment 1: **Fort McClellan's Draft SI Report states that 42 surface soil, five depositional soil, 42 subsurface soil and four groundwater samples were collected and analyzed for Target Analyte List (TAL) metals, nitroaromatic/nitramine explosives and perchlorate. A minimum of ten percent (11 of 93) of the samples were additionally analyzed for Target Compound List (TCL) volatile organic compounds (VOCs). TCL semivolatile organic compounds (SVOCs), chlorinated herbicides, chlorinated pesticides and organophosphorous pesticides.**

The methodology used to select the eleven samples for further analysis is unclear to ADEM. The eleven samples selected were from only six sample locations, all of which were located in the western portion of the site. Two soil sample locations (four samples) were located outside the western boundary of Parcel 215Q. The Department believes that the limited number of samples selected for further analysis and the limited area where these samples were collected are insufficient to fully characterize potential contamination at this site. Therefore the Department does not concur with Fort McClellan's recommendation that Parcels 89Q-X and 215Q be designated as No Further Action (NFA) and unrestricted land reuse.

Response 1: The approach for this SI was presented to the BCT at the February 2002 project team meeting. The BCT agreed with the proposed approach regarding the numbers and types of samples as well as the analyses to be performed. Because of this site's historical use as a weapons training/demonstration range, metals, explosives, and perchlorate were considered the most likely contaminants of potential concern. Therefore, analysis for a broader range of chemicals (e.g., VOCs, SVOCs, pesticides, and herbicides) at all sample locations was not considered necessary. The locations for full-suite analysis were generally placed in areas with the most observed features (i.e., those areas most likely to be contaminated). This information was added to the text.

The report was revised to include separate recommendations based on the spatial distribution of contamination and the future property owners (i.e., Joint Powers Authority [JPA] or U.S. Fish & Wildlife Service [USFWS]). The JPA portion of the property, which contains the visible bullet fragments, was recommended for disposition according the agreed upon requirements in the Environmental

Services Cooperative Agreement (ESCA)/Technical Specifications and Requirement Statement (TSRS) and the Cleanup Agreement between the Alabama Department of Environmental Management (ADEM) and JPA. The USFWS portion of the property was recommended for "No Further Action" based on the analytical data and the absence of bullets within that portion of the site. In addition, the Anniston Water Works and Sewer Board (AWWSB) water tank site, located at the far western end of the area of investigation, was also recommended for "No Further Action."

Response to Environmental Protection Agency Comments on the Draft Site Investigation Report Range 31: Weapons Demonstration Range, Parcel 89Q-X and Former Defendum Field Firing Range No. 2, Parcel 215Q Fort McClellan, Calhoun County, Alabama

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Comments from Doyle T. Brittain, Senior Remedial Project Manager, dated April 14, 2003.

General Comments

Comment 1: The reason for collecting only four groundwater samples from five monitoring wells should be clarified in both the Executive Summary and the Summary and Conclusions.

Response 1: Comment noted. The text was revised per comment.

Comment 2: The COPC selection process for both human health and ecological risk must be redone to follow the technical memorandum on background comparison that the Army is writing. Additionally, the issue of bullet fragments present in various areas of the site must be resolved with regard to ecological risk.

Response 2: Comment noted. Site metals data were re-evaluated in accordance with the background screening protocol agreed to by the BCT in March 2003. The three-tiered process consists of statistical testing and geochemical evaluation to select site-related metals. The background screening methodology is described in the technical memorandum "Selecting Site-Related Chemicals for Human Health and Ecological Risk Assessments for FTMC: Revision 2," (Shaw Environmental, Inc., 2003).

Comment 3: It would help in understanding the distribution of chemicals if the discussion for surface soil samples was separate from the discussion of deposition soils.

Response 3: Because they are collected from the same depth interval (0 to 1 foot bgs), surface and depositional soil data have always been reported together in the numerous SI and RI reports issued by Shaw.

Comment 4: A summary table needs to be added to the section 5.0 including the COPC, maximum and average concentrations, location of maximum concentration, frequency of detection, ESV, and BTV. This table would assist in the review of the PERA for this site.

Response 4: Comment noted. A PERA was not performed for this site.

Response to Environmental Protection Agency Comments on the Draft Site Investigation Report Range 31: Weapons Demonstration Range, Parcel 89Q-X and Former Defendum Field Firing Range No. 2, Parcel 215Q Fort McClellan, Calhoun County, Alabama

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Specific Comments

Comment 1: **<u>Page 1-3, Line 1</u>. The discussion which begins on this line describes the weapons which have most likely been fired at this range. This description does not mention 30 caliber rounds which were used in both the M-1 rifle and the 30 caliber machine gun. Since this range is described as having been used in the 1950s and 1960s, and since the M-1 rifle and the 30 caliber machine gun were the primary infantry weapons during time, it is likely that hundreds of thousands of these rounds were fired on this range. This should be clarified.**

Response 1: Comment noted. Information presented in the EBS stating that "A large amount of .30-cal lead projectiles were observed within this range during the EBS site visit" was inadvertently omitted from the draft report. This information was added to the revised report.

Comment 2: **<u>Page 6-2, Line 22</u>. This line states that three copper concentrations were only marginally higher than the alternative screening value of 60 mg/kg. While this statement is true for two of the exceedances, it is not true when discussing the maximum concentration which was 86 mg/kg. The text should be clarified to ensure that descriptive words are used appropriately.**

Response 2: Comment noted. The text was revised based on the results of the background screening protocol. The sentence in question was deleted.

Comment 3: **<u>Page 6-2, Line 3</u>. This line states that bullet fragments are present on the ground surface in some areas of the site. The presences of the bullet fragments must be addressed in a more comprehensive manner, such is being done for the various firing ranges. Please note that EPA considers lead on ranges at Fort McClellan to be the release of a hazardous substance pursuant to CERCLA § 104(a), and therefore needs to be reported and handled accordingly. The areas containing lead fragments should be mapped. All of these visible lead fragments should be removed, even from areas that do not exhibit elevated soil concentrations.**

Response 3: Comment noted. The report was revised to include separate recommendations based on the spatial distribution of contamination and the future property owners (i.e., Joint Powers Authority [JPA] or U.S. Fish & Wildlife Service [USFWS]). The JPA portion of the property, which contains the visible bullet fragments, was recommended for disposition according to the agreed-upon requirements in the

Environmental Services Cooperative Agreement (ESCA)/Technical Specifications and Requirement Statement (TSRS) and the Cleanup Agreement between the Alabama Department of Environmental Management (ADEM) and JPA. The USFWS portion of the property was recommended for "No Further Action" based on the analytical data and the absence of bullets within that portion of the site. In addition, the Anniston Water Works and Sewer Board (AWWSB) water tank site, located at the far western end of the area of investigation, was also recommended for "No Further Action."

Comment 4: **<u>Page 6-3, Line 4</u>. The final conclusion is that compounds detected in site media do not pose an unacceptable risk to human health and the environment. Until the issue of bullet fragments has been resolved, this conclusion can not be supported.**

Response 4: See previous response.

Comment 5: **<u>Appendix A</u>. Comparisons of the Sample Collection Logs with the Chain of Custody Records indicated some inconsistencies. In all cases, the name of the person relinquishing custody on the Chain of Custody form does not appear on the sample collection log as one of the samplers. In addition, in the Received-By block on nine of the Chain of Custody Records, a printed name is included instead of a signature. Unless these inconsistencies can be satisfactorily explained, chain of custody was not maintained on these samples.**

Response 5: Disagree. Shaw followed the procedures outlined in Section 6.1.7.1 *Field Custody Procedures* presented in the *Draft Installation-Wide Sampling and Analysis Plan*, Revision 3, February 2002 (SAP). This section states, "The sampling team, sample coordinator, and site manager will maintain overall responsibility for the care and custody of the samples until they are transferred or properly dispatched to the on-site screening facility and/or fixed-based laboratory." In addition, SAP Section 6.1.7.2 *Transfer of Custody and Shipment* states, "General custody of the sample will be maintained by the sample collection team members from the time of collection in the field through preparation and shipment to the laboratory. The main custody transfer will occur when the sample shipment is received into the laboratory from the field and is documented." Similar language is also provided in the QAP.

Using these two sections as guidance, <u>all</u> Shaw field personnel who are responsible for the collection of field samples (which includes the sample coordinator and the site manager) were considered part of the "sample team." No custody transfer record was considered necessary among members of the *same* sample collection team. If another contractor, a subcontractor to Shaw, the Army, or other personnel had collected samples and transferred them to Shaw for processing or analysis, then the transfer of custody of those samples would have been formally recorded using a COC form.

Multiple sample technicians were responsible for collecting samples and completing the sample collection logs. The samples and logs were funneled to the Shaw sample coordinator, who then reviewed the documentation, inventoried all of the samples collected, and compiled a single COC record to list all the samples collected (daily) for transfer to the receiving analytical laboratories. Therefore, the sample coordinator's signature on the form represents the transfer of custody from the Shaw sample team in the field to the analytical laboratory personnel (per Section 6.1.7.2 of the SAP). Shaw believes that this is satisfactory custody transfer documentation and, therefore, does not agree this indicates that sample custody was not maintained as stated in the comment. Shaw personnel followed the same chain-of-custody procedures that have been in effect since the beginning of the FTMC project in 1998. It is perplexing that until now these issues have never been called into question.

However, in light of recent comments received by EPA, Shaw has changed its COC procedures to include a separate COC for each sample collection team. Each sample collection team will submit samples, COCs, and SCLs to the sample coordinator. The SCLs and COCs will be reviewed by the sample coordinator prior to taking possession of the samples and signing the COC. This process will be repeated for each sample collection team in the field. The COCs will then be copied for the field records and maintained onsite. The original forms will be transmitted to the office for filing in the project central files. In future reports, this appendix will include all "supplementary" sample team COCs to document intra-team custody transfers and all SCLs.

Regarding the second part of the comment: Is EPA implying that someone's "signature" can only be made through cursive writing? If an individual willingly marks a document and affirms that the mark is indeed his own, then the manner in which that mark is made and the form that mark takes are irrelevant.

Response to U.S. Fish & Wildlife Service (USFWS) Comments
Draft Site Investigation Report
Range 31: Weapons Demonstration Range, Parcel 89Q-X and
Former Defendum Field Firing Range No. 2, Parcel 215Q
Fort McClellan, Calhoun County, Alabama

Comments received from Mr. Larry E. Goldman, USFWS, on February 10, 2004.

General Comments

Comment 1: **The Site Investigation Report does not provide information on habitat characteristics or biological conditions of the site. Such information is needed to adequately understand the ecological importance of the area, the significance of potential threats, and the implications of selecting a particular course of action. We recommend adding appropriate information on habitat types and biological communities.**

Response 1: Comment noted. However, this level of information is outside of the scope of a site investigation (SI) according to the CERCLA process and the terms of this contract. An SI is conducted to confirm the presence or absence of contamination in site media. A remedial investigation (RI) is conducted to determine the nature and extent of the contamination. As part of the RI, conditions at the site are studied, the problem(s) are identified, and alternative methods to clean up the site are evaluated (i.e., a feasibility study is also performed).

Reference: USEPA, 1992, ***CERCLA/Superfund Orientation Manual, EPA/542/R-92/005***, October.

Comment 2: **We were informed in a November 18, 2003, meeting with Ft. McClellan staff that visible lead particles were removed from soil samples prior to conducting chemical analyses. As such, the concentrations and overall risks of lead at this site are likely underestimated. The Site Investigation Report should note that bullets and lead fragments were removed from soil samples prior to analyses. The report should note the amounts, general form (e.g., whole bullets and/or fragments), and size ranges of lead particles removed from analytical samples. Such information is needed to evaluate long-term human health and ecological risks associated with this site.**

Response 2: Comment noted. The text in Section 3.2.1 was revised to indicate that any visible bullet fragments observed during surface soil sampling were removed prior to sample collection. Please note, however, that this only occurred at the locations indicated as "Ammunition Fragments" on Figures 1-2 and 3-1 (Observed Feature No. 20). That is, this did not occur on USFWS property.

Comment 3: **We are concerned about the potential for increases in ecological risk of lead and other potentially toxic metals at this site over time. The solubility, mobility, and toxicity of most metals increase under acidic conditions. Acidic conditions would also promote increased rates of degradation of metal particles, thereby enhancing the biological availability of the metals. Information provided in Section 4.1.2 (Site Geology) indicates that the dominant soils in this parcel are "strongly acidic." Additionally, data provided in Appendix C (Well Development Logs) indicate that groundwater is also acidic. As such, site conditions appear to favor enhanced solubility, mobility, biological availability, and toxicity of lead and, potentially, other toxic metals. Additionally, the site will likely be subjected to periodic controlled burns, in accordance with refuge management objectives. Burning may also alter the biogeochemical cycling and long-term availability of lead and other metals. The potential for site conditions to contribute to increased ecological risk of metals over time should be considered prior to making any decisions regarding the need for remedial action at this site. Additional information on the prevalence of particulate lead, rates of particle degradation, changes in mobility and biological availability, and potential changes to the overall ecological risk at this site is needed to facilitate such decisions.**

Response 3: See response to general comment no. 1.

Comment 4: **Figure 1-2 (Site Map) depicts Cave Creek as flowing most of the length of the range. Section 4.2 (Site Hydrology) identifies Cave Creek as one of the "major surface water features" of Fort McClellan. However, no discussion of surface water quality or contaminant concerns in aquatic habitats at the site is provided in the Site Investigation Report. Such information is important for evaluating the need for further action at the site. Please provide a description of Cave Creek and other aquatic habitats potentially occurring at the site. If Cave Creek is ephemeral, the frequency, duration, and volume of flow should be discussed. As part of the above evaluation, the collection of water sample from this creek is recommended to evaluate surface water.**

Response 4: Comment noted. A brief overview of Cave Creek characteristics was added to the text. However, the remainder of the reviewer's request is outside the scope of an SI. Also, please note that four surface water/sediment samples were planned for this investigation but could not be collected because surface water was not present in the intermittent stream at the time of sample collection. However, depositional soil samples were collected at these locations.

Comment 5: **We are concerned about the potential for water, including stormwater, flowing from this site to exceed applicable water quality standards. Such exceedances would have significant implications to future land management activities and could constitute future liabilities of land managers. We recommend the collection of additional information to evaluate these concerns. We believe that such information is critical to making an informed decision regarding the need for action at this site. We recommend providing discussions on surface water flow paths and downstream water bodies receiving drainage from the site. The characteristics and overall quality of these water bodies should be discussed. If appropriate, stormwater runoff samples should be collected for chemical analysis. If contaminant concentrations in stormwater have the potential to exceed ecological screening values, risks to organisms associated with receiving waters should be delineated. Similarly, land manager liabilities should be discussed if stormwater has the potential to cause exceedances of applicable water quality standards.**

Response 5: The SI is complete; additional sampling will not be performed. Should additional sampling be agreed upon by the BCT, it will be done as part of an RI.

Comment 6: **We were informed in a November 18 and 19, 2003, meeting that the Army intends to apply Net Environmental Benefit Analysis (NEBA) at Fort McClellan. NEBA would be used to ascertain the overall benefits of potential remediation projects and to determine appropriate compensatory restoration for contaminated areas that will not be fully remediated. As indicated in the Site Investigation Report, environmental contamination exceeded applicable screening values and some level of risk occurs within Parcel 89Q-X. We look forward to working with you to determine the need for remedial action and/or to identify appropriate restoration opportunities.**

Response 6: Comment noted.

Comment 7: **The Site Investigation Report recommends "No Further Action" at this site. We believe that such a determination is premature. Additional information is needed to appropriately evaluate the current and future implications of contamination at this site to wildlife, aquatic life, and habitat quality and to identify future land management liabilities. If the potential for significant ecological risks of future land manager liability exists, the Army should conduct a Remedial Investigation/Feasibility Study for this site.**

Response 7: Comment noted. The report was revised to include separate recommendations based on the future property owners (i.e., Joint Powers Authority [JPA] or U.S. Fish & Wildlife Service [USFWS]). The JPA portion of the property, which contains the visible bullet fragments, was recommended for disposition according to the agreed-upon requirements in the Environmental Services Cooperative Agreement (ESCA)/Technical Specifications and Requirement Statement (TSRS) and the Cleanup Agreement between the Alabama Department of Environmental Management (ADEM) and JPA. The USFWS portion of the property was recommended for "No Further Action" based on the available analytical data and the absence of bullets within that portion of the site. In addition, the Anniston Water Works and Sewer Board (AWWSB) water tank site, located at the far western end of the area of investigation, was also recommended for "No Further Action."

Specific Comments

Comment 1: **3.2.1 Surface and Depositional Soil Sampling**
Section 1.3 (Site Description and History) identified an excavated area in the northeastern portion of the range that contained "stressed vegetation, mounds, depressions, and ammunition blanks." However, Table 3-1 (Sampling Locations and Rationale) and Figure 3-1 (Sample Location Map) indicate that no samples for chemical analysis were collected from this area. This site would appear to present some ecological concerns. We recommend the collection of appropriate samples to ascertain the chemical quality of this site.

Response 1: The proposed approach for this SI was presented to the BCT at the February 2002 project team meeting. The BCT agreed with the proposed approach regarding the numbers and types of samples as well as the analyses to be performed. Because of this site's historical use as a weapons training/demonstration range, metals, explosives, and perchlorate were considered the most likely contaminants of potential concern. Therefore, analysis for a broader range of chemicals (e.g., VOCs, SVOCs, pesticides, and herbicides) at all sample locations was not considered necessary.

Comment 2: **Intermittent stream: Section 1, Figure 1-3**
The Range Location Map (Figure 1-3) depicts a number of intermittent streams within the area of investigation. Discussions of the frequency and magnitude stream flow and the overall quality of stream water should be included in the Site Investigation Report.

Response 2: Comment noted. See response to general comment no. 1.

Comment 3: **Depositional Soil Analytical Results: Table 5-1, pp. 1-2**
Four metals (aluminum, chromium, iron, vanadium) were detected at levels exceeding their respective ESV's at all five depositional soil sample sites. Aside from HR-89Q-DEP01, these samples were taken from intermittent stream beds. We are concerned that these metals may be

mobilized when flowing water is present. Additionally, acidic conditions in site soils could enhance the mobility and toxicity of some of these metals. We recommend the collection of additional information to better characterize the potential risk of metals in intermittent stream beds to fish, wildlife, and downstream water quality.

Response 3: Comment noted. See response to general comment no. 1.

Comment 4: **Miscellaneous scrap: Section 3, Figure 3-1**

Figure 3-1 notes the occurrence of assorted scrap and debris at this site. The Site Investigation Report should provide an account of scrap and debris occurring at the site and discuss chemical and/or physical hazards associated with such debris.

Response 4: Comment noted. See response to general comment no. 1.

Comment 5: **Section 5 (Summary of Analytical Results)**

The Site Investigation Report should provide a table and discussion on water quality parameters measured in the field. Such information, particularly information on pH, is needed to understand the behavior and overall threat to metals at the site.

We note the detection limits for several of the trace elements, including some metals, in the water samples exceed applicable water quality standards and ecological screening values. The potential for the "non-detected" constituents to represent a risk to ecological receptors should be addressed. To the extent practical, future chemical analyses at this and other sites on Ft. McClellan should strive to attain detection limits lower than applicable screening values and water quality standards.

It appears that mercury concentrations were not determined in ground water samples. Please provide the rationale for not determining mercury concentrations in water. Also, please provide a discussion of the potential for mercury in water to represent potential risks to human health or the environment. If appropriate, additional water samples should be collected for mercury analysis.

Response 5: Table 3-6 summarizes groundwater field parameters at the time of sample collection. Aside from a slight elevation in groundwater turbidity in the samples collected from HR-89Q-MW04 and –MW05, these parameters are unremarkable.

The detection limits are those achieved by the laboratory using the methods specified in the approved Fort McClellan installation-wide SAP and QAPP. They reflect the sample preparation steps and difficulties encountered with the matrices analyzed. The limits represent what were practically achievable by the laboratory using the method-required protocols. The laboratory strives to achieve the lowest reasonable detection limit for each analyte without taking extraordinary steps that would significantly increase the complexity of the analysis and the cost to the Army.

As stated in *Section 3.4 Analytical Program*, the samples collected for this investigation were analyzed for target analyte list metals (including mercury) using EPA Methods 6010B/7470A/7471A. Methods 7470A/7471A are the analyses for mercury.

The analytical summary tables provided in Chapter 5.0 of the SI report include only those metals that were detected at levels above reporting limits. Because mercury was not detected in groundwater, it does not appear in Table 5-3. Appendix F contains the complete summary of validated analytical data.

Comment 6: <u>**Section 6.0, pages 6-1 and 6-2**</u>
Conclusions about ecological risk in this section are based on several approaches to reducing the list of contaminants or dismissing them, including successive screens for metals data, amounts by which ESVs were exceeded, contaminants distribution in site media, and habitat quality. We believe that the Service and other natural resource trustees should be party to such decisions. We look forward to discussing these approaches with the USACE-Mobile District.

Response 6: Comment noted.